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RESEARCH MEMORANDUM

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ABSTRACT

This paper explains : (i) why fixed rate loan commitments exist in a competitive credit market with universal risk neutrality and no transactions costs, and (ii) why banks exist to sell such commitments. The economy has each borrower facing uncertainty about future interest rates and about its project "type." Each borrower seeks to finance its project with a bank loan and takes an unobservable action which, along with the realization of its type, determines the probability distribution of its project payoff. A loan commitment is rationalized on the grounds that it resolves moral hazard even more effectively than the use of inside equity in conjunction with spot credit. However, the commitment market breaks down if populated by individual commitment sellers who are economically rational (not pathologically honest), i.e., refuse to honor commitment contracts whenever it is privately optimal to do so. The existence of a bank -- dealing with many borrowers -- is justified on the grounds that, unlike an individual commitment seller, even an economically rational bank can make credible promises to honor all its commitment contracts. A perfect sequential equilibrium is characterized in which borrowers buying loan commitments choose first-best actions and the banks selling them honor their contracts.

CREDIBLE COMMITMENTS, CONTRACT ENFORCEMENT PROBLEMS AND BANKS:

INTERMEDIATION AS CREDIBILITY ASSURANCE

I. INTRODUCTION

A. Objectives

Why do individuals buy insurance from insurance companies and rarely from other individuals? Why are individuals willing to pay up-front fees to firms or organizations for the future delivery of products or services (examples are health clubs, professional organizations, hotels, etc.) but not to other individuals? Why is it that a person who is willing to pay an established commercial airline his full airfare weeks in advance of the flight is unlikely to behave similarly with an individual pilot offering to fly him in a private aircraft? Why is it that loan commitments are sold by banks and not by individuals?

All these questions have the same answer. Firms can credibly commit to supply a product or service in the future in exchange for current compensation. Individuals often can not. It is this notion that provides the building blocks for our explanation of why banks exist (as commitment sellers).

The goals of this paper are threefold. The first is to provide an economic rationale for the existence of bank loan commitments in an environment characterized by universal risk neutrality, interest rate uncertainty and takedown uncertainty stemming from randomness in the future values of investment projects borrowers intend financing with commitment takedowns. The second is to formally show that a market for loan commitments can exist even though the commitment seller has an incentive to renege on its promise to lend at subsidized terms. And the third is to provide a novel justification for the existence of banks. This justification is provided in two steps. The first step is to show that an individual (non-intermediary) commitment seller may have an incentive to renege on its promise to lend. This causes a loan commitment market breakdown manifested in the absence of market-mediated, bilateral (forward) credit exchanges between borrowers and commitment sellers. The second step then involves showing that an organizational solution, involving a bank intermediating between borrowers and lenders and selling commitments, restores economic incentives to honor contracts. Thus, a bank arises because it lends credibility to credit commitments and assures market participants that contracts will be honored.

The intended contribution of this paper is to two strands of the financial intermediation literature. One is the literature on loan commitments and the other is the literature on the existence of financial intermediaries.

B. The Loan Commitment Literature and Overview of the Model

Loan commitments in the U.S. currently amount to billions of dollars. The formal literature on loan commitments is now fairly extensive and can be traced back to Campbell's (1978) partial equilibrium analysis of the supply and demand determinants of fixed and variable rate loan commitments. Since then, numerous papers have attempted to explain why these instruments exist. However, until recently,[1] most explanations have relied on either risk aversion or transactions costs.[2] Risk aversion is useful in understanding why individuals demand loan commitments to insure themselves against random future interest rates. However, it is less compelling as an explanation for the bulk of loan commitment demand which stems from corporations owned by diversified shareholders. Thus, it seems important to explain why loan commitments may be demanded by risk neutral agents. While transactions costs may be useful in understanding why certain types of prearranged lines of credit exist, it is difficult to use them to explain why most loan commitments involve some rigidity in the borrowing rate under the commitment.[3] A loan commitment with a pure liquidity motivation should involve the bank lending at the commitment customer's spot borrowing rate. But we almost never observe such commitments.[4]

We provide a competitive equilibrium justification for loan commitment demand by risk neutral agents. This is achieved with a two-period, universally risk neutral economy in which borrowers have insufficient liquidity to finance investment projects that will be available one period hence. They can arrange the financing externally by either purchasing a loan commitment now for funds availability one period hence or by planning to borrow in the spot market a period from now. The loan commitment guarantees funds at a fixed interest rate even though the future spot rate is random. A fee must be paid by the borrower for this facility at the time of purchase of the commitment. The payoff distribution of the borrower's project is affected both by an unobservable action choice of the borrower at the start of the first period and by the realization of an observable technological quality (type) parameter at the start of the second period. For the borrower, the commitment is an option; it will be exercised only if the borrower's type realization is such that investment in the project is value enhancing and the commitment offers a lower rate than spot borrowing. The credit market is competitive, implying that contracts are designed to maximize each borrower's expected utility, subject to the lender breaking even. This problem is modeled as a non-cooperative (Nash) game between the lender and the borrower.

We begin by showing that if the borrower is restricted to spot borrowing, the Pareto dominant Nash equilibrium is welfare-distorting; it involves a lower-than-first-best action choice by the borrower. The reason is that the loan interest rate has a distortionary effect on the supply of productive inputs such as effort.[5] We then show that with a fixed rate loan commitment offered to the borrower prior to its action choice, the commitment rate can be set low enough to restore the borrower's incentive to choose a first-best action. Whatever loss the bank may suffer from offering such a low interest rate can be recovered by charging the borrower a commitment fee at the time it purchases the commitment. It is assumed that the borrower has sufficient initial liquidity to pay the commitment fee. Surprisingly, however, we prove that, from the borrower's standpoint, the alternative of purchasing a loan commitment Pareto dominates that of saving the initial liquidity and using it as inside equity in conjunction with a spot loan. This part of our analysis thus generalizes the work of Boot, Thakor and Udell (B-T-U) (1987). They obtain the same result with a simpler model in which there is no uncertainty about the borrower's type and commitments are always taken down.

C. Contract Enforcement and the Existence of Banks

A key assumption in the above analysis -- and that of B-T-U -- is that the bank always honors its commitment. However, since the commitment is a put option[6] that is exercised by the borrower only when the commitment rate is lower than the spot borrowing rate, a borrower takedown imposes a loss on the commitment seller. Why should the commitment seller adhere to the terms of the contract? When we explicitly analyze this issue, we find that an individual commitment seller -- one that obtains funds from depositors and sells a commitment to a single borrower -- will, under some conditions, renege on its promise to lend. Thus, a loan commitment market comprised of individual lenders cannot exist. But if the commitment seller is a bank -- an intermediary that obtains funds from depositors and sells commitments to numerous borrowers -- then we show that there exists a perfect sequential equilibrium in which the bank always honors <u>all</u> of its commitments and all commitment buyers choose first-best actions. Thus, banks arise as institutions to assure credibility.

In our model we permit two situations, one in which the commitment seller can renege with impunity and the other in which it is penalized. Being able to costlessly renege corresponds to the ubiquitous "escape clause" in real world loan commitment contracts. This clause stipulates that the commitment seller need not honor a commitment if the borrower's financial condition has "materially deteriorated." We model "material deterioration" in order to identify specific states in which reneging is costless.

Our research is related to the literature on contractual performance. The problem typically studied in that literature is as follows. Two parties, a seller and a buyer, enter into a contract stipulating that the seller produce a good and deliver it at a specified price. This contracting precedes the observation of any cost and value information by the two parties. The buyer then makes a transaction-specific investment which has little value if the seller does not honor the contract. Next, the seller observes this production cost. If this cost is very high, he defaults and makes a side-payment to the buyer according to a prespecified legal rule called the "damage measure." The buyer's investment decision and the seller's decision of whether or not to breach the contract jointly determine the level of efficiency attained. Shavell (1980) uses this framework to assess the economic performance of commonly used damage measures, without permitting recontracting. Shavell (1984) and Rogerson (1984) allow recontracting after the seller's observation of production cost, but conclude that efficiency is *un*attainable. In all three papers, all payoff-relevant information can be communicated credibly. This assumption is relaxed in Konakayama, Mitsui and Watanabe (1986), where an optimal price and damage payment schedule that attains efficiency is derived.

The similarities between the basic model used in these papers and ours are transparent. Also related to our work are papers in which reputation-driven, market-based contract enforcement mechanisms are considered in settings where sellers have an incentive to not honor their contractual commitments to buyers. An example of such papers is Klein and Leffler (1981).

What sets our paper apart from these is that the (commitment) seller's incentive to honor its contract can be guaranteed neither through explicit legal remedies nor through implicit, market-based reward/punishment mechanisms. This is not to say that these effects are not important, but we take this scenario as the starting point of our analysis and show that an organizational solution to the contract enforcement problem works precisely in the circumstances in which a non-organizational solution fails. The idea formalized here is that it is more costly for an organization to not honor its contractual commitments than it is for an individual seller. When a given structure of penalties under the law cannot guarantee that individuals will abide by contracts, there is potential market failure which is effectively prevented by the emergence of organizations. Thus, our approach seems capable of more generally explaining why firms exist (see, for example, Williamson (1975)). We have chosen to focus on <u>financial intermediaries</u> to lend specificity to our analysis. The key difference between our research and the existing literature on financial intermediary existence (Boyd and Prescott (1986), Diamond (1984), Millon and Thakor (1985) and Ramakrishnan and Thakor (1984) are recent examples) is that the latter <u>assumes</u> that contracts will be honored and rationalizes intermediary existence on the grounds that it reduces expected contracting costs by more efficiently resolving moral hazard or pre-contract private information problems.

The rest of the paper is organized as follows. Section II presents the basic model and the full-information equilibrium. Section III introduces moral hazard and rationalizes loan commitments under the assumption that commitments will always be honored. In Section IV, contract enforcement problems are introduced and a rationale for the existence of banks is provided. Section V concludes. All formal proofs are in an appendix (Appendix II). Throughout, we are careful to distinguish between "banks," "lenders," and "commitment sellers." The term "lender" designates an individual lender, be it a commitment seller or a spot lender, whereas a "bank" is either a spot lender or a commitment seller that deals with many borrowers. The term "commitment seller" designates either a lender or a bank that sells commitments.

II. THE MODEL AND THE FULL INFORMATION SOLUTION

A. The Model

(i) Preferences and Market Structure: Consider a perfectly competitive, two period credit market in which lenders compete for both deposits and loans. All agents are risk neutral. Consequently, credit contracts are designed to maximize the net expected profits of borrowers subject to the constraints that the lender's depositors receive an expected return equal to the riskless rate and the lender's shareholders earn zero expected profit. Deposits are completely uninsured.[7] For simplicity, we assume that currently the lender has no equity capital that can be used as a funding source for the loan.[8] The supply of deposits is perfectly elastic at the spot riskless rate. Taxes are assumed to be zero throughout.

(ii) Agent Types, Endowments and Basic Time Structure: There are two time periods. The first period begins at t=0 and ends at t=1. The second period begins at t=1 and ends at t=2. There are potentially five different types of agents in the economy and there is a countable infinity of each agent. Each type 1-A agent has a cash endowment of R_f^{-1} at t=0 and nothing else, where R_f is the (commonly known) single period riskless interest factor at t=0. Type 1-B agents are not in existence at t=0 but come into existence at t=1, each with a \$1 cash endowment. There is no useful distinction at t=1 between type 1-A agents who save their initial liquidity for a period, and type 1-B agents. Both these agent types are potential depositors. Type 1-A agents can lend their money to commitment sellers at t=0, enabling them to make (forward) commitments to lend at t=1. Type 1-B agents can only be depositors in the spot credit market at t=1.

Type 2-A agents are endowed with projects at t=0. There is no investment -- either capital or labor -- required to activate these projects. Each project yields a fixed payoff of $S > 0$ at t=2. However, the payoff is completely unobservable to all except the agent who owns the project. Thus, this agent can consume this payoff without detection. The only way that the agent owning the project can be prevented from consuming S is if a court of law "attached" the project and took legal possession of it. In that case, the court can divert S' to some other agent. We assume that $S' = \varepsilon \in (0, S)$ is very small to capture the idea that there is a high verification and title transfer cost associated wtih taking over the project; S' can thus be viewed as S minus the dissipative cost of diverting consumption away from the initial owner of the project. Each type 2-A is a potential (individual) commitment seller and groups of type 2-A agents are potential banks. Type 2-B agents have no project endowment, but they are observationally indistinguishable at t=0 from type 2-A agents. Thus, they could mimic these agents. A verification cost of ν could be incurred to perfectly distinguish a type 2-A agent from a type 2-B agent.

Type 3 agents are endowed at t=0 with options to invest in projects at t=1. Each of these projects requires a \$1 investment at t=1. The project pays off at t=2 and the payoff distribution depends on an unobservable action choice of the type 3 agent. At t=0, each type 3 agent starts out with a liquidity of $L \in (0, R_f^{-1})$. Since this liquidity can be carried for a period at R_f, the type 3 agent will have LR_f of its own funds to invest at t=1 if it simply saves its liquidity and borrows the rest in the spot market at t=1. But since $LR_f < 1$, external financing will still be needed to activate the project.

To recapitulate, type 1-A and 1-B agents are the depositors, type 2-A agents are the lenders (or commitment sellers or banks), and type 3 agents are the borrowers in this economy. Henceforth, we will refer to these agents as depositors, lenders and borrowers. References to agents by (primitive) types will only be made where needed. The reason why a lender is needed to intermediate between a depositor and a borrower will become apparent later.

(iii) First Period (Environmental Uncertainties and Decisions): At t=0, each borrower has two choices. It can either plan to save its initial liquidity entirely for a period and then borrow $1 - LR_f$ in the spot market at t=1, or it can purchase a loan commitment at t=0. The commitment will guarantee availability of credit (up to a predetermined maximum) at t=1 at some contractually predetermined (fixed) interest rate. To purchase the commitment, the borrower must pay a commitment fee, $g \geq 0$, at t=0. Because the commitment fee will be financed from the initial liquidity, L, the borrower will need a larger loan under the commitment than with spot borrowing. It is assumed throughout that when a borrower purchases a loan commitment, the purchase becomes common knowledge.

At t=0, the borrower can undertake one of three actions, 0, a_1, or a_2 with $a_1 > a_2 > 0$. The action choice affects the payoff distribution of the project the borrower will have available at t=1. (The manner of this effect will be made precise shortly.) The action a_i should be viewed as developmental activity that precedes the actual investment in the project. It includes R & D, pre-product introduction advertising, sales promotions through featured campaigns, etc. Undertaking the action is costly for the borrower. The costs are $V(a_i)$, with $\infty > V(a_1) > V(a_2) > V(0) = 0$. We define $V(a_i)$ as the value of the effort disutility at t=2, i.e., it is the compounded value (at t=2) of the borrower's disutility for having chosen action a_i at t=0. (This is simply a scaling issue). If the borrower chooses a=0, then the project it invests in at t=1 will yield a cash flow of zero almost surely at t=2 (the end of the second period). In what follows, we shall assume that, if an equilibrium exists, then the borrower's reservation utility of zero (which results from choosing a=0) is always exceeded by the equilibrium utility (associated with an action choice a_1 or a_2). Thus, a=0 will never be an optimal action choice and henceforth, we will simply assume, for the most part, that the borrower's feasible action space is $\{a_1, a_2\}$.

Having chosen its action at t=0, the borrower faces three types of uncertainties. First, it does not know the actual (random) cash flow that will be realized at t=2. Second, it does not even know the probability distribution of this cash flow[9] that it will face at t=1. The reason is that this probability distribution is affected both by the borrower's action choice at t=0 and by some technological "quality" parameter related to the project. This technological parameter will become known only at t=1. Third, the borrower and the lender are currently unaware of the riskless spot rate that will occur at t=1, although its probability distribution is common knowledge. This uncertainty is important to the borrower if it accesses the spot credit market at t=1, because its spot borrowing rate will depend on the prevailing riskless spot rate. By purchasing a fixed rate loan commitment, however, the borrower can eliminate uncertainty about its loan interest rate.

We assume that, with spot credit contracting, the only instruments available to the lender are: (i) the loan size (or how much equity to ask the borrower to put up) and (ii) the loan interest rate.[10] The same instruments are available with a loan commitment, except that there is an additional degree of freedom in that part of the borrower's equity can be offered to the lender (commitment seller) at t=0 as a commitment fee.[11]

<u>(iv) Second Period (Investment Technology, Environmental Uncertainties and Credit Utilization Decisions)</u>: Having made its decisions regarding action choice (a_1 or a_2) and contract choice (loan commitment or spot borrowing), the borrower makes two observations at t=1. One observation is of the technological quality parameter, k, of its project. Let $k \in \{G, B\}$, where G indicates "good" quality and B indicates "bad" quality. The parameter k should be interpreted as a summary statistic representing market demand conditions, production costs, etc., that the borrower was unaware of initially but learns prior to investing capital in the project. Viewed at t=0, all agents have homogeneous beliefs about k, as embodied in the following probability measures: $\Pr(k = G) = \Psi \in (0, 1)$, $\Pr(k = B) = 1 - \Psi$, where "Pr" denotes probability. The second observation the borrower makes is of the spot riskless rate. Conditional on the single period spot riskless interest factor of R_f at t=0,

the single period spot riskless interest factor, R, at t=1 can take one of two possible values, R_ℓ or R_h. We assume $1 < R_\ell < R_h < \infty$. Viewed at t=0, all agents have homogeneous beliefs about R, as embodied in the following probability measures: $\Pr(R = R_\ell) = \theta \in (0, 1)$, $\Pr(R = R_h) = 1 - \theta$. We will refer to R as the random variable representing the spot riskless factor at t=1 and $R_j \in \{R_\ell, R_h\}$ as its realization. It is assumed that, for any borrower, k and R are independent random variables and that their realizations at t=1 are common knowledge. Moreover, the k's for different borrowers are also independent random variables.

Having observed k at t=1, the borrower knows the cash flow distribution of its investment opportunity; the only remaining uncertainty for the borrower is the actual cash flow that will be realized at t=2. Specifically, the cash flow will be $X(a_i,k)$ with probability (w.p.) $p(a_i)$ and zero w.p. $1 - p(a_i)$, with $X(a_1,k) > X(a_2,k)$ $\forall$ $k \in \{G, B\}$ and $X(a_i,G) > X(a_i,B)$ $\forall$ $a_i \in \{a_1, a_2\}$. For any two borrowers with the same a_i and the same k, the project cash flows are identical and independently distributed (i.i.d.) random variables. With its observations of k and R_j in hand, the borrower now makes its investment and credit utilization decisions. If it had purchased a loan commitment at t=0, then it must decide: (i) whether to invest in the project and (ii) whether to take down the loan commitment or borrow in the spot market. If it did not purchase a loan commitment, its only decision is whether to invest in the project at the currently available credit terms. Table 1 summarizes the timing of realizations of random variables and the sequence of decisions.

There is potential moral hazard since the action a_i of the borrower is unobservable to the lender, although in this section we assume that the lender can freely observe the borrower's action choice. Thus, despite knowing the technological quality of the project, the lender generally does not know the borrower's payoff distribution when it lends to it. This moral hazard differs from that in the standard principal-agent model in that the action choice (at t=0) in our model precedes the contract choice of the lender (at t=1). That is, the informed agent moves first here. At t=1, the loan interest factor charged by the lender for a spot loan can then be written as $r(a_i | R_j)$. This means that the spot credit price depends on the realization of the riskless spot interest factor, $R_j \in \{R_\ell, R_h\}$, and on the lender's beliefs about the borrower's action choice, $a_i \in \{a_1, a_2\}$.[12] Note that r does not depend on the lender's observation of k since the technological quality of the project affects only the cash flow in the good state and not the probability of success. The lender extends (spot) credit only if the loan interest rate that allows it to at least break even, given its belief about a_i, is such that the borrower's repayment obligation is exceeded by the cash flow in the good state. Thus, the cash flow size has no impact on r, conditional on credit being extended.

At t=2, the end of the second period, the borrower observes the actual realization of its project cash flow. Under asymmetric information, however, the lender can only observe whether or not the borrower's project was successful. It can not observe the actual cash flow. If the lender extends a loan at a given interest rate, then all it knows -- or can agree with the borrower upon -- is that, given the borrower's optimal (unobservable) action choice in response to the offered loan contract, the return in the successful state exceeds the promised repayment.[13] It is, however, common knowledge that the project cash flow is zero if there is failure and it is positive if there is success. All of these assumptions taken together imply that (costless) ex post payoff-contingent contracts of the Bhattacharya (1980) type are precluded. Moreover, given the ex post unobservability assumption, the analyses of Diamond (1984), Gale and Hellwig (1985), and Townsend (1979) can be used to show that the optimal contract between the bank and the borrower is a pure debt contract.[14]

B. The Full Information Outcome

Under full information, the lender can costlessly observe both the borrower's action choice and its return in the successful state. Moreover, type 2-A and type 2-B agents are observationally distinguishable so that only the former become lenders. If the borrower self-finances, its expected utility can be written as (throughout this paper, the borrower's alternatives to investing in the project are current consumption or, equivalently, investment in the riskless asset; thus, all expected utilities are to be taken as the increments in expected utility resulting from investing in the project, i.e., the total expected utility from investing in the project minus the expected utility from investing in the riskless asset)

$$p(a_i)[\Psi X(a_i, G) + \{1 - \Psi\}X(a_i, B)] - V(a_i) - [\theta R_\ell + \{1 - \theta\}R_h] \quad (1)$$

assuming that the borrower has sufficient liquidity to self-finance. (Assume for the moment that the borrower starts out at t=0 with a liquidity of R_f^{-1} so that it has exactly \$1 to invest at t=1.) In (1) the last term is the compounded value of the \$1 investment made at t=1. As done in (1), we shall always write expected utility in terms of its wealth equivalent at t=2. We shall assume that the borrower prefers to choose a_1 when it self-finances. That is,

$$p(a_1)\ [\Psi\ X\ (a_1,G) + \{1-\Psi\}\ X\ (a_1,B)] - V(a_1) - [\Theta\ R_\ell + \{1-\Theta\}\ R_h]$$

$>$

$$p(a_2)\ [\Psi\ X\ (a_2,G) + \{1-\Psi\}\ X\ (a_2,B)] - V(a_2) - [\Theta\ R_\ell + \{1-\Theta\}\ R_h]$$

which means

$$p(a_1)\ [\Psi\ X\ (a_1,G) + \{1-\Psi\}\ X\ (a_1,B)] - V(a_1)$$

$$> \qquad \text{(PR-1)}$$

$$p(a_2)\ [\Psi\ X\ (a_2,G) + \{1-\Psi\}\ X\ (a_2,B)] - V(a_2)$$

By (PR-1) we mean the first parametric restriction on the model. As we proceed, we will impose more parametric restrictions on the model. Henceforth, we will assume that

$$R_f = \Theta\ R_\ell + [1-\Theta]R_h.$$

Now suppose the borrower's liquidity, L, is insufficient to permit complete self-financing. An amount $1 - LR_f > 0$ must be borrowed at t=1. The borrower's expected utility can now be written as

$$\begin{aligned} EU(a_i) &= p(a_i)[\Psi\{X(a_i,\ G)-\lambda_1\} + \{1-\Psi\}\{X(a_i,\ B)-\lambda_1\}] - V(a_i) \\ &\quad - LR_f\{\Theta\ R_\ell+\{1-\Theta\}R_h\}, \end{aligned} \qquad (2)$$

where

$$\lambda_1 \equiv [1 - LR_f][\Theta\ r\ (a_i|R_\ell) + \{1-\Theta\}r(a_i|R_h)].$$

In (2), λ_1 is the borrower's expected repayment obligation to the bank and $LR_f[\Theta\ R_\ell + \{1-\Theta\}R_h]$ is the compounded value of the liquidity (equity) the borrower relinquishes by investing in the project. The borrower's decision problem is to choose its optimal action, a_i^*, to satisfy

$$a_i^* \in \underset{a_i\in\{a_1,a_2\}}{\operatorname{argmax}}\ E\ U(a_i). \qquad (3)$$

It is straightforward to verify that a_i^* is chosen to yield the borrower the same expected utility it enjoys when it has sufficient liquidity to completely self-finance, i.e., the first best is attained. To see this, note first that, in a competitive credit market, lenders price their spot loans to earn zero expected profits. This is because the equity the lender has in its own project does not support the loan. Thus,

$$r(a_i|R_j) = R_j/p(a_i) \ \forall a_i \in \{a_1, a_2\}, \ R_j \in \{R_\ell, R_h\}. \tag{4}$$

Using (4) and a little algebra, we obtain

$$EU(a_i) = p(a_i) \ [\Psi X(a_i, G) + \{1-\Psi\}X(a_i, B)] - V(a_i) - R_f,$$

which is the same as its expected utility with complete self-financing, expressed in (1). Thus, $a_i^* = a_1$, and the first best is attained.

III. MORAL HAZARD AND A RATIONALE FOR LOAN COMMITMENTS (NO EX POST CONTRACT ENFORCEMENT PROBLEMS)

We have seen in the previous section that, absent moral hazard, the borrower can use spot credit without welfare depletion. We now examine what happens when the borrower's action choice is ex post unobservable to the lender. There is also imperfect ex post observability of the terminal cash flow; the lender can observe success or failure of the project, but not the actual cash flow.

A. Definition of Equilibrium

In this section we study, in each case, a _(fulfilled expectations) competitive Nash equilibrium_. The equilibrium is affected by the beliefs of market participants. Consider spot credit contracting first. At t=0, the borrower forms a belief about the (best) contract that will be available to it in the spot credit market at t=1, and this belief guides its action choice. Similarly, at t=1, the lender forms a belief about the action chosen by the borrower at t=0 (since borrowers' action choices are unobservable), and this belief affects the contract it is willing to offer. The equilibrium allocations are conditioned on a specified system of beliefs, and the equilibrium is such that these beliefs are rationalized (expectations are fulfilled.) Such an equilibrium in the spot credit market obtains when the following conditions are met.

(i) Conditional on a given system of beliefs, the lender offers a set (possibly a singleton) of credit contracts such that, given the contracting environment, there does not exist another (feasible) set of contracts that makes the borrower strictly better off under that system of beliefs. (Feasibility here means that the lender earns non-negative expected profit.) Moreover, the expected utility of the borrower with the chosen contract is non-negative.

(ii) The borrower's belief is rationalized in that the best credit contract available at t=1 is the same as the one the borrower believed would be available to it when it chose its action at t=0.

(iii) The credit contract taken by the borrower at t=1 is such that the offering lender earns zero expected profit on the contract, conditional on the borrower having chosen the action the lender believes it chose.

(iv) The lender's belief is rationalized in that the borrower chooses the same action at t=0 that the lender believes it did.

When we consider a setting in which lenders can offer loan commitments and also lend in the spot market, the Nash equilibrium has all of the features listed above, but it also satisfies the following additional conditions. (For now, we take as given the assumption that the commitment seller will always honor the loan commitment contract, i.e., lend to the borrower when the commitment is exercised.)

(i) Conditional on a given system of beliefs, the commitment seller offers a set (possibly a singleton) of loan commitment contracts at $t=0$ such that there does not exist any other (feasible) loan commitment contract that makes the borrower strictly better off under that system of beliefs. Moreover, the expected utility of the borrower with the chosen contract is non-negative.

(ii) Given the conditions that: (a) the borrower will exercise the commitment at $t=1$ if it offers better terms than spot credit and use spot credit otherwise, and (b) the commitment seller will honor the loan commitment contract, the commitment seller earns zero expected profit on the loan commitment if the borrower chooses the action the commitment seller believes it will.

(iii) The commitment seller's belief is rationalized in that the borrower taking the loan commitment chooses the action the commitment seller believes it will.

For future reference, note that the commitment seller's own project will never be prematurely liquidated as long as it honors its commitment. Premature liquidation is a punitive measure that is relevant only when contract enforcement problems are explicitly recognized.

B. Spot Credit With No Borrower Equity

For moral hazard to exist, we must have a situation in which the borrower has an incentive to exploit the lender's informational handicap. To characterize a benchmark case, we assume for now that the borrower takes a \$1 loan at $t=1$, i.e., it does not use any of its initially available liquidity. Moreover, the borrower consumes its initial liquidity at $t=0$, leaving the lender with a zero payoff in case the project fails. That is, if the lender prices its spot loan at $t=1$ under the belief that the borrower chose a_1 at $t=0$, then the borrower should choose a_2 at t=0 <u>in anticipation</u> of such a pricing policy by the lender. The following parametric restriction ensures this.

$$
\begin{aligned}
&p(a_2)\{\Psi[X(a_2,G) - r(a_1|R_\ell)] + \Theta[1-\Psi][X(a_2,B) - r(a_1|R_\ell)] \\
&\quad + \Psi[1-\Theta][X(a_2,G) - r(a_1|R_h)] + [1-\Psi][1-\Theta][X(a_2,B) - r(a_1|R_h)]\} - V(a_2) \\
&> \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \text{(PR-2)} \\
&p(a_1)\{\Theta\,\Psi[X(a_1,G) - r(a_1|R_\ell)] + \Theta[1-\Psi][X(a_1,B) - r(a_1,R_\ell)] \\
&\quad + \Psi[1-\Theta][X(a_1,G) - r(a_1|R_h)] + [1-\Psi][1-\Theta][X(a_1,B) - r(a_1|R_h)]\} - V(a_1) \\
&\quad + \epsilon
\end{aligned}
$$

where ϵ is an arbitrarily small positive number. (PR-2) will be assumed to hold throughout. It says that the first best credit contract is not incentive compatible. (PR-2) is actually stronger than this since it says that the borrower's expected utility from choosing a_2 exceeds that from choosing a_1 by an amount greater than some small positive number, ϵ. The reason for assuming such slackness in this condition will become apparent later. It should be noted that this moral hazard problem exists despite borrower risk neutrality. This is in contrast to the standard result of principal-agent models that a first best can be reached with a risk neutral agent. Underlying that "standard" result is the assumption that limited liability is not a concern, either because the agent has no limited liability protection provided by the contracting environment or because debt is riskless. We have <u>risky</u> debt here with limited liability. Thus, the borrower (agent) is unable to (credibly) guarantee a sure payment to the lender, giving rise to moral hazard.

In addition to (PR-2), we also introduce some parametric restrictions that will prove useful in narrowing down the range of possibilities in this model. Before doing that, however, we need the following notation. Define a random variable $\xi \equiv (k, R)$ as follows:

$\xi_1 \equiv (G, R_\ell)$, $\xi_2 \equiv (G, R_h)$, $\xi_3 \equiv (B, R_\ell)$ and $\xi_4 \equiv (B, R_h)$.

Let $\Xi \equiv \{\xi_1, \xi_2, \xi_3, \xi_4\}$ be the state space of ξ. We will refer to ξ as taking values in Ξ to mean that the realization of ξ can be ξ_i with $i \in \{1, 2, 3, 4\}$. The remaining parametric restrictions are now stated below.

$$
\begin{aligned}
&\text{(i) } X(a_2,k) - r(a_i|R_h) < 0 \ \forall a_i \in\{a_1, a_2\},\ k \in\{G, B\} \\
&\text{(ii) } X(a_2,k) - r(a_i|R_\ell) > 0 \ \forall a_i \in\{a_1, a_2\},\ k \in\{G, B\} \qquad \text{(PR-3)} \\
&\text{(iii) } X(a_1,k) - r(a_i|R_j) > 0 \ \forall a_i \in\{a_1, a_2\},\ \xi \in \Xi\backslash\xi_4 \\
&\text{(iv) } X(a_1,B) - r(a_i|R_h) < 0 \ \forall a_i \in\{a_1, a_2\}
\end{aligned}
$$

where the notation $\Xi\backslash\xi_4$ means all the elements of Ξ except ξ_4. The interpretations of (PR-3) are as follows. By (i) we mean that a borrower which has chosen a_2 will never take spot credit at t=1 if the riskless spot rate is high, regardless of its project's technological quality and the lender's belief about its action choice. By (ii) we mean that a borrower which has chosen a_2 will always seek spot credit at t=1 if the riskless spot rate is low, regardless of its project's technological quality and the lender's belief about its action choice. By (iii) we mean that a borrower which has chosen a_1 will seek spot credit in all circumstances except when its project's technological quality is bad and the spot riskless rate is high; (iv) says that in <u>that</u> case, the borrower will not want spot credit. The next parametric restriction is

$$\Psi[1-\Theta]p(a_i)[X(a_i, G) - r(a_i|R_h)] - V(a_i) < 0 \ \forall\ a_i \in\{a_1, a_2\}. \qquad \text{(PR-4)}$$

This condition, taken in conjunction with (iv) in (PR-3), implies that, if the borrower anticipates being rationed in the spot credit market whenever the spot riskless rate is low, it will prefer autarky to borrowing, and choose a = 0 at t=0.

The final parametric restriction is

$$p(a_2)\ \{\Theta\ \Psi[X(a_2,\ G)\ -\ r(a_2|R_\ell)]\ +\ \Theta[1-\Psi][X(a_2,\ B)-r(a_2|R_\ell)]$$
$$-\ V(a_2)\ >\ 0. \tag{PR-5}$$

All that this inequality says is that the borrower will choose to participate in the spot credit market even though it can borrow only in the low interest rate state and receives a correctly priced loan for having chosen a_2.

We would like (PR-1) to be compatible with the other parametric restrictions. That is, we want a_1 to be the desired action choice in the first best (complete self-financing) case even when (PR-3) holds. Note that, given (PR-3), the borrower will never invest at t=1 if the spot riskless rate is high and it had chosen a_2 at t=0, even though it can completely self-finance the investment. The reason is that it can do better by investing in the riskless asset instead. Similarly, if it chose a_1 at t=0, then it will never invest when k=B and $R=R_h$ because investing in the riskless asset is a superior alternative. Thus, using (PR-3) yields the following version of (PR-1)[15]

$$p(a_1)\{\Theta\ \Psi[X(a_2,G)\ -\ r(a_1|R_\ell)]\ +\ \Theta[1-\Psi][X(a_1,B)\ -\ r(a_1|R_\ell)]$$
$$+\ [1-\Theta]\Psi[X(a_1,G)\ -\ r(a_1|R_h)]\}\ -\ V(a_1)$$
$$> \tag{PR-1'}$$
$$p(a_2)\{\Theta\ \Psi[X(a_2,G)\ -\ r(a_2|R_\ell)]\ +\ \Theta[1-\Psi][X(a_2,B)\ -\ r(a_2|R_\ell)]\}\ -\ V(a_2)$$

Throughout the remaining analysis, we assume that (PR-1') through (PR-5) hold. The reason for imposing these parametric restrictions on the model is that we want to focus on a limited set of outcomes. This not only eases our computational burden but also enables the economic intuition to be brought out more sharply. For the most part, these restrictions are useful in shortening the proof of the claim (to follow) that Nash equilibria in the spot credit market are inefficient, i.e., involve welfare distortions relative to first best. Since this is the basic premise with which we begin our analysis, the parametric restrictions do not sacrifice much generality. We now have the following result.

LEMMA 1: There exists at least one competitive Nash equilibrium in the spot credit market. The Nash equilibrium yielding the borrower its highest expected utility is the one in which the lender charges $r(a_2|R_\ell)$ if $R_j = R_\ell$ and $r(a_2|R_h)$ if $R_j = R_h$. In this equilibrium the borrower experiences a lower than first best expected utility.

This result is intuitive. The competitive spot borrowing rate is so high -- particularly in the high interest rate state -- that the borrower's share of the terminal cash flow is too low to induce a choice of the first best action, a_1. Thus, a_2 is chosen. The key observation is that any increase in the loan interest rate diminishes the borrower's marginal return to effort. This incentive effect is distortionary because it causes the borrower to curtail effort supply.[16]

C. The Deposit Contract

For lenders that only enter the spot credit market at t=1, the deposit contract is simple. Consider initially a lender that deals with just one borrower. It raises $1 from depositors to make a loan to the borrower. If the borrower's project is successful at t=2, the lender passes along all of the principal and interest it collects to the depositors. If the project fails, depositors get nothing. (Note that, given our earlier assumptions, depositors cannot claim S unless there is court intervention which is unnecessary if depositors take into account the probability of project failure ex ante in pricing deposits.) With many borrowers, ex post returns will be divided on a pro rata basis among depositors. However, since depositors are risk neutral, diversification across many borrowers does not enhance their welfare. Thus, nothing is lost by simply assuming that a dollar raised from a specific group of depositors is earmarked for a specific borrower and that those depositors get paid in full if the borrower's project succeeds and get nothing if it fails. The bank will not have to pay any additional (risk) premium for such a policy.

For a bank that issues a *loan commitment* at t=0, the deposit contract is as follows. The bank issues a two-period CD at t=0 and raises $\$R_f^{-1}$. At t=0, the bank invests in the riskless asset -- so that it has $1 in loanable funds available at t=1 -- since risky investment opportunities in this economy are only available at t=1. At t=1, if state ξ_2 occurs for the loan commitment customer, then it takes down the commitment and the bank lends it $1. At t=2, depositors are paid $gR_fR_h + \delta$ if the borrower's project is successful, and gR_fR_h if the project fails. Note that gR_fR_h is the compounded value of the commitment fee, conditional on state ξ_2 occurring. We assume throughout that the commitment fee is always invested in the riskless asset. (This is an innocuous assumption.) In states ξ_1, ξ_3 and ξ_4 for the borrower in question, the loan commitment is *not* taken down. In these cases, the bank seeks out some other borrower to lend to in the spot credit market at t=1. We will show later in this section that all borrowers who purchase loan commitments at t=0 choose a_1. From among these borrowers, those who find themselves in states ξ_1 and ξ_3 at t=1 will be candidates for spot loans. We will assume that the borrower the bank lends its idle funds to is one of these borrowers. Thus, the interest factor charged to the borrower is $R_j/p(a_1)$ where $R_j \in \{R_\ell, R_h\}$. Suppose, on the other hand, the bank lends its money at t=1 to a borrower that did not purchase a loan commitment at t=0. Then we know from our earlier analysis that such a borrower chose a_2 at t=0. Thus, if the competitive loan interest factor the bank charges is $R_j/p(a_2)$. In other words, the purchase of a loan commitment at t=0 affects the borrower's borrowing rate in the future even if it does not exercise the commitment. Since depositors can always write (at t=0) a contract that makes their payoff at t=2 conditional upon the kind of borrower (one who purchased a commitment at t=0 versus one who did not) the bank lends to in the spot market at t=1, we will assume, without loss of generality, that the bank's spot lending is only to a borrower who had purchased a commitment at t=0.[17] Thus, if either state ξ_1 or ξ_3 occurs at t=1, the depositors are paid $gR_fR_\ell + R_\ell[p(a_1)]^{-1}$ if the (spot) borrower's project is successful and gR_fR_ℓ if it fails. If state ξ_4 occurs, then depositors are paid $gR_fR_h + R_h[p(a_1)]^{-1}$ if the spot borrower's project is successful and gR_fR_h if it fails.

We see then that the two-period CD contract is structured in such a way that the depositors always get the same expected return over two periods $(R_f^2 - 1)$ regardless of whether the loan commitment purchaser takes down the loan commitment or lets it expire unexercised. Moreover, the bank always makes a zero profit. Thus, the state-contingent CD contract is consistent with the competitive market structure we have assumed.

All of this rests, however, on the critical assumption that the bank always honors the loan commitment. The question of what happens if the bank reneges on its promise is taken up in the next section.

D. Summary of Key Assumptions

The key assumptions made thus far are summarized below to enable the reader to keep track of the model structure.

(i) All agents are risk neutral, the lender has zero initial equity capital, and the credit market is perfectly competitive.

(ii) There are three points in time, t=0, 1, 2. At t=0, the (prospective) borrower chooses an action (zero, low or high). At t=1, a technological quality parameter is realized (good or bad). In combination, action and quality determine the payoff distribution of the borrower's project. Capital investment in the project occurs at t=1 and a random cash flow (zero or positive) is recovered at t=2. The borrower's action choice and the realized cash flow are ex post unobservable at t=2. However, the lender can observe whether the project failed (zero cash flow) or succeeded (positive cash flow). All else is common knowledge.

(iii) Conditional on a known single period riskless interest rate at t=0, the riskless spot rate at t=1 can be either low or high. The riskless spot rate and the project's technological quality are independent random variables and the riskless spot rate does not affect the project's payoff distribution.

(iv) In the first best case -- when the borrower completely self-finances its project -- the high action is preferred by the borrower to the low action. However, complete self-financing is not possible since the borrower's available liquidity at t=1 is less than the $1 investment required for the project.

(v) There is moral hazard when the lender lends to the borrower. That is, if the lender prices its spot loan at t=1 under the belief that the borrower chose the high action at t=0, the borrower will, in fact, choose the low action at t=0 in anticipation of such a pricing policy.

(vi) A borrower who chooses the low action at t=0 will never invest in the project at t=1 if the spot riskless rate is high, regardless of the lender's belief about its action choice. Such a borrower will, however, invest at $t=1$ if the spot riskless rate is low, regardless of the lender's belief about its action choice.

(vii) A borrower who chooses the high action at $t=1$ will always invest in the project at $t=1$ unless the "worst" combination of events occurs, i.e., its technological project quality is low and the riskless spot rate is high. In that case, the borrower does not invest.

(viii) At $t=0$, if the borrower believes it will be rationed at $t=1$ in the event that the low interest rate is realized, then it will prefer autarky (choose a zero action) to investment and participation in the credit market at $t=1$. But if it believes that rationing will occur only in the high interest rate state, then it will invest and participate in the credit market, i.e., it will at least choose the low action at $t=0$ and borrow at the available credit terms at $t=1$ for investment purposes.

(ix) The purchase of a loan commitment at $t=0$ is publicly observable and becomes common knowledge at $t=0$.

(x) The lender issues a two-period CD at $t=0$. This CD stipulates a state-contingent payoff vector for depositors at $t=2$. The depositors' payoff at $t=2$ depends on the realization of the riskless spot rate and the borrower's takedown decision at $t=1$ as well as on whether the borrower's project succeeds or fails at $t=2$. The depositors' payoff vector is designed to ensure that the depositors' expected return (viewed at $t=0$) is the <u>same</u> (and equal to the riskless rate) regardless of the borrower's takedown decision.

E. Spot Credit With Borrower Equity Versus Loan Commitments

It is the distortionary incentive effect of the borrowing rate that creates room for the emergence of contractual mechanisms to reduce the welfare loss attributable to moral hazard. We consider two mechanisms. One calls for the borrower to provide (inside) equity and reduce its spot borrowing. This is the standard approach to coping with moral hazard (see Jensen and Meckling (1976), for example). The other calls for the borrower to use its initial liquidity to purchase a loan commitment instead. In this subsection we compare the borrower's welfare under each alternative and show that a loan commitment always strictly Pareto dominates the spot credit cum equity outcome. Our approach is to show that the amount of equity input required to induce a choice of a_1 strictly exceeds (in present value terms) the commitment fee required to induce a choice of a_1. Thus, with a sufficiently binding constraint on initial liquidity, a loan commitment will restore first best action incentives but borrower equity participation will not. In what follows we assume that the commitment seller always honors its contract and lends to the borrower whenever the commitment is exercised. In the loan commitment contract, we take $\delta \in (R_\ell[p(a_1)]^{-1}, R_h[p(a_1)]^{-1})$, so that the commitment may expire unexercised. Table 1 summarizes the different states and the borrower's takedown and investment behavior in those states.

THEOREM 1: Assuming that the commitment seller will always honor its commitment, there exists a loan commitment contract that induces the borrower to choose a first best action and yields the commitment seller zero expected profit. Moreover, there exist values of the borrower's initial liquidity, L, for which this loan commitment contract strictly Pareto dominates any spot credit market equilibrium (attainable with partial equity financing) and produces a first best level of expected utility for the borrower.

This is a surprising result. A well known approach to coping with the moral hazard linked to external financing is to require the firm to supply more inside equity. In the limit, complete self-financing (all inside equity) eliminates moral hazard. However, a firm with demand for investment funds that outstrips its available liquidity will be compelled to seek external financing. In our model, this external financing is (optimally) raised through a risky debt contract. The existing literature says that the distortion-minimizing solution is for the borrower to use <u>all</u> of its available liquidity as an equity input and obtain debt financing for the rest. The presumption, of course, is that the borrower has access only to the spot credit market. What we have demonstrated is that the borrower with access to a forward credit market should purchase a loan commitment rather than save its liquidity for use as equity in combination with a spot loan.

The intuition behind this result is best understood in two steps. First, we will see why a loan commitment yields the borrower its first best expected utility. At t=0 the borrower purchases a loan commitment that guarantees funds availability at t=1 at a fixed interest rate. The contract stipulates that the borrower pay the commitment seller a commitment fee $g > 0$ at t=0 and receive a \$1 loan at some fixed interest factor δ. Now, the commitment seller will set δ just low enough to ensure that the borrower's marginal return to effort is at least as great as the level needed to ensure a choice of a_1 at t=0. That is, the distortionary effect of the loan interest rate is eliminated by setting it sufficiently low. Of course, at this low interest rate, the commitment seller suffers an expected loss on the loan.[18] To recoup its loss, the commitment seller charges a commitment fee g at t=0; this fee permits it to exactly break even on the loan commitment contract. However, the commitment fee has _no_ incentive effect because it is paid "up-front" and represents a "sunk cost" for the borrower, i.e., it does not impact its action choice. Thus, the borrower chooses a_1 and enjoys a first best level of expected utility. The second step is to understand why partial (inside) equity financing in conjunction with a spot loan is not as effective as a loan commitment. Note that a fixed rate loan commitment pegs the loan interest rate at the same level regardless of the riskless spot rate.[19] Thus, it reduces the customer's repayment obligation by different percentages in the low and high interest rate states. Specifically, it provides a greater percentage reduction in the high interest rate state. And this is the state in which the distortionary effect of the loan interest rate is the most severe with spot credit contracting. Partial equity financing, on the other hand, reduces the borrower's repayment obligation _evenly_ across both the low and the high interest rate states, which is less efficient. We next have the following observation.

COROLLARY 1: Theorem 1 holds even if the borrower faces no technological quality uncertainty about its project.

This observation is precisely the central result in B-T-U (1987). Thus, our analysis in this section generalizes the B-T-U (1987) results to a more complex environment than the one considered there.

IV. LOAN COMMITMENTS WITH EX POST CONTRACT ENFORCEMENT PROBLEMS; A RAISON D'ETRE FOR BANKS

For notational ease, we will assume that, although type 2-A and type 2-B agents are observationally identical, they can be distinguished at a cost $\nu=0$. Assuming $\nu > 0$ does little to alter the analysis. However, the possibility of $\nu > 0$ has some implications for the organizational form of the bank we rationalize. These are discussed later.

A. The Contract Enforcement Problem

The option-like feature of a loan commitment implies that the commitment seller provides a subsidized loan when the borrower exercises the commitment.[20] This creates an incentive for the seller to renege on its promise to lend under the commitment. Although we have assumed thus far that the commitment seller must honor the commitment, in practice the commitment seller does have some leeway in determining whether or not to honor the commitment. In particular, if it can establish that the borrower's financial condition deteriorated materially between the time of issue of the loan commitment and the time of takedown, then it may be legally unencumbered from its obligation. Of course, there must be costs for the commitment seller if it refuses to honor the commitment when the borrower's financial condition does not warrant it; otherwise, the commitment would never be honored. These costs could be loss of reputation, explicit legal damages, etc. It would be rather easy to show that the commitment will always be honored if we simply assume an exorbitantly high cost for not honoring it. However, this has the effect of trivializing the ex post contract enforcement problem. Moreover, arbitrarily high penalties will generally not be feasible. The issue of what constitutes an "appropriate" penalty will be addressed shortly.

Under what circumstances is it reasonable to assume, in the context of our model, that the commitment seller could costlessly renege? One obvious circumstance is the occurrence of state ξ_4. In this state, the borrower has a negative NPV from its capital investment alone (not taking the effort disutility, $V(a_1)$, into account) even if it had chosen a_1 at t=0.[21] We assume that if the borrower wants to exercise the commitment and the commitment seller reneges in a state other than ξ_4, then a costly but perfect *ex post* audit can be conducted by the courts to determine the borrower's realized project payoff. (We do not address the issue of who bears the audit cost incurred by the court. Assuming that this cost is borne by the party that loses the case only adds more notation.) Because a borrower's type realization at t=1 is common knowledge, an audit of the realized cash flow, conditional on project success, will permit an exact inference of the borrower's action choice. (Recall that the cash flow in the successful state is a deterministic function of the borrower's type and its action choice.) If the borrower is found to have chosen a_1 (in keeping with the "spirit" of the loan commitment contract), then the commitment seller must pay damages to the borrower. But if a_2 is detected, then the commitment seller can keep the commitment fee and pay nothing to the borrower. Note, however, that if the borrower is unsuccessful, its realized cash flow is zero regardless of its type and action choice. Having observed project failure, an audit of the cash flow would be useless since it is common knowledge that the cash flow is zero and noninformative about the agent's action choice. (Direct observation of a_1 is not possible.) The borrower may also optimally choose not to purchase the commitment, in which case the loan commitment game ends with a zero payoff to the commitment seller and depositors at t=0. (In this event, the borrower will choose a_2 in anticipation of using spot credit and inside equity at t=1.)

In states ξ_1 and ξ_3, the borrower optimally decides to let the commitment expire unexercised. Thus, the only relevant state to focus on is ξ_2. If state ξ_2 occurs and the commitment seller reneges, the borrower has two choices. It can either do nothing or it can take legal action against the bank. Since the court will audit the ex post cash flow, we can assume, without loss of generality, that the borrower will choose its legal action at t=2 after observing its cash flow. A borrower which observes project success but had chosen a_2 at t=0 will optimally decide to do nothing since it is made worse off by pursuing legal action. Also, a borower which observes project failure will not sue. In either case, the bank, which had invested the commitment fee in the riskless asset (as in states ξ_1, ξ_3 and ξ_4) and loaned its deposit funds to a spot borrower who had purchased a commitment from some other bank at t=0, can keep its revenues. The depositors are promised $gR_fR_h + \delta$ if the project succeeds and gR_fR_h if it fails. Of course, a borrower which chose a_1 at t=0 and is successful at t=2 will want to sue a bank that reneges in state ξ_2. In this case, there are two questions. What will be the likely outcome? And, if the borrower wins, what will be the penalty imposed on the lender? Not being legal experts, we feel somewhat ill-equipped to answer these questions.[22] However, as economists we can make assumptions that are consistent with rational economic behavior by the courts. Since in state ξ_2 the financial condition of a borrower which chose a_1 has not "materially deteriorated," the lender has <u>no</u> justification for not honoring the commitment. Thus, we assume that the borrower will win the law suit. The question of the "appropriate" penalty is more difficult. Therefore, we will consider the most stringent possible penalty and discuss the possible effects of a variety of penalty structures. Note that all that the lender has at t=2 is the revenue collected on the spot loan made with the $1 of deposits it had available at t=1 plus a revenue of gR_fR_h resulting from its commitment fee being invested in the riskless asset, plus its shareholders' projects. Since depositors are <u>not</u> party to the lender's decision to renege on its commitment, the courts are unlikely to view as equitable a judgement that takes away as a penalty the depositors' claim against the bank's assets at t=2. For simplicity, we assume depositors' funds are protected by legally binding "me-first" rules. However, the rest of the lender's assets are confiscated as a penalty. This includes the compounded value, gR_fR_h, of the fee revenue and the shareholders' projects. Note that this leaves the bank's shareholders with <u>nothing</u> and thus constitutes the stiffest penalty among those penalties that protect the depositors' claim. The penalty collected from the lender will be paid to the commitment holder. As in the other states, we assume that the lender will lend the depositors' \$1 to a (risky) borrower in the spot market at t=1. However, the promised payment to the depositors at t=2 must be modified if they are to obtain the same expected return as in the other states. This is because the commitment fee revenue is lost when the lender is successfully sued and hence not invested in the riskless asset to provide depositors a payoff of gR_fR_h in <u>both</u> the success and failure states at t=2. Thus, we assume that the deposit contract stipulates two different payoff rules, one for the case in which the lender is successfully sued at t=2 and the other for the case in which it is not. If the lender is not successfully sued at t=2, then the depositors get $gR_fR_h + \delta$ if the borrower to whom the lender loaned its funds succeeds and gR_fR_h if that borrower fails. If the lender is successfully sued at t=2, then the depositors get $gR_fR_h[p(a_1)]^{-1} + \delta$ if the borrower to whom the lender loaned its funds is successful and zero if that borrower is unsuccessful. <u>Table 2</u> summarizes the payoffs to the commitment seller, the borrower and the depositors at t=2 in depositors at t=2 in states ξ_1, ξ_3 and ξ_4, and for the different strategies the commitment seller could pursue. Table 2' presents this information for state ξ_2. These payoffs are for $a = a_1$; those for $a = a_2$ can be analogously written.

In this environment, if a lender contracts with just one loan commitment customer, then the penalty on the lender for not honoring the commitment contract is that all of the terminal wealth of the lender's shareholders is passed along to the commitment holder. With multiple loan commitments, however, some borrowers may exercise their commitments while others do not. If the lender reneges on a subset of the commitments that are exercised, we assume that successful legal action by those who sue will result in all of the lender's equity net of title transfer costs being distributed pro rata to the plaintiffs. This makes sense because it provides the courts with the maximum feasible penalty that can be levied on a "nonperforming" lender.

The force of these assumptions is that the depositors' expected return is made independent of both the borrower's decisions of whether or not to take down the commitment and whether or not to sue the bank for not honoring the commitment in state ξ_2 as well as the lender's decision of whether or not to honor the commitment. This has the virtue of making the depositors' strategy at t=0 independent of their beliefs regarding these actions of the borrower and the lender. The only belief of relevance for the depositors is regarding the borrower's action choice since this choice affects the probabilities with which the depositors receive their various state-contingent payoffs. The equilibrium concept we will adopt puts restrictions on this belief.

B. Definition of Additional Terms and Equilibrium

When the borrower can take an action at t=0 that the commitment seller cannot observe and the commitment seller can adversely affect the borrower by choosing not to honor the commitment at t=1, beliefs that both parties hold at the outset crucially affect the equilibrium. It is, therefore, useful to adopt an equilibrium concept in which the explicit assignment of beliefs guides the determination of equilibrium. We use the Grossman and Perry (1986) "perfect sequential equilibrium" (PSE) concept, a refinement of the Kreps and Wilson (1982) "sequential equilibrium." This requires some additional terms, which are defined in Appendix I. (We focus on pure strategy PSE).

<u>A Competitive PSE With a Loan Commitment (CPSELC)</u>: An updating rule for the commitment seller and metastrategies for the commitment seller, depositors and the borrower form a competitive PSE if

(i) all of the metastrategies are sequentially perfect;

(ii) the commitment seller's updating rule is credible with respect to all the metastrategies;

(iii) the commitment seller earns zero expected profit;

(iv) depositors earn an expected return equal to the riskless rate of return, regardless of the commitment seller's actions and the borrower's takedown behavior; and

(v) there does not exist any other loan commitment contract with the associated sequentially perfect metastrategies for all parties concerned and a credible updating rule for the commitment seller such that the borrower enjoys a higher expected utility with it, the commitment seller earns zero expected profit and the depositors obtain an expected return equalling the riskless rate.

C. Definition of Bank

A bank is defined as a collection of two or more equityholders dealing with at least one borrower and one depositor.

A large bank is a collection of many equityholders dealing with many borrowers and many depositors.

D. A Loan Commitment as a Bilateral Credit Exchange: The Non-Bank Case

There are two cases to consider. First, we could have a direct exchange between a borrower and a depositor, bypassing the lender. That is, a borrower could approach a depositor at t=0 and purchase a loan commitment. The difficulty with this arrangement is that the depositor could collect the commitment fee and simply proceed to consume its cash endowment of R_f^{-1} at t=0. The commitment would then not be honored at t=1 and no legal enforcement mechanism could remedy the situation. Of course, the borrower could simply approach a depositor directly for spot credit at t=1. But we have already shown that a loan commitment produces a superior outcome. Thus, this approach is inefficient.

The other case is that of a bilateral contract at t=0 between an individual commitment seller and a borrower. The advantage of having a commitment seller intermediate between a borrower and a seller is that it can acquire funds from a depositor at t=0 and thus prevent the depositor from consuming its endowment at t=0. Of course, incentives must be provided to the commitment seller to induce it to ensure that the commitment contract is honored. Under this arrangement, the commitment seller promises to lend up to $1 should the borrower wish to take such a loan at t=1. The funds to support this commitment are raised through a two-period CD as discussed earlier. To analyze the equilibrium that results in the game between the commitment seller, the borrower and the depositors, we need to define each party's payoff in each state of nature. We will not list the depositors' payoff since our description of the CD contract has that information.

To understand each party's incentives, we have an extensive form for this game in Figure 2. Depositors are excluded in this sketch, for reasons that will be apparent later. In this extensive form, nature is treated as a passive player. We refer to the borrower's decision to take down the loan commitment as "x," its decision not to exercise the loan commitment but borrow in the spot market as "y," and its decision to not invest at all (avoid both commitment takedown and spot market borrowing) as "z." All of these decisions are made at t=1, conditional on the borrower having purchased the commitment at t=0. The borrower's decision to purchase the loan commitment at t=0 is referred to as "ℓ" and its decision to *plan* to borrow in the spot market as "s." Payoffs are indicated as usual at the terminal node. The first term in any payoff pair is the borrower's expected utility (assessed over its net payoff at t=2) and the second term is the commitment seller's expected wealth at t=2. Both expectations are assessed at t=1, i.e., after ξ has been realized but prior to the realization of the random cash flow from the borrower's project. Suppose first that the borrower has chosen a_1. Then in state ξ_1, the borrower does not exercise the commitment and goes to the spot credit market. Let U_1^1 be the borrower's expected utility in this case. (Our notational convention is to denote the borrower's expected utility by U_j^i where i denotes action a_i and j denotes state ξ_j; the only exception is when a commitment is taken down, in which case j is replaced by c.) The commitment seller lends its deposit funds (\$1) in the spot credit market and its expected payoff is zero from the loan and S in total. In state ξ_2, the borrower exercises the commitment. If the commitment seller decides to honor its commitment (a decision denoted by "h"), the borrower's expected utility is U_c^1 and the commitment seller's expected payoff is S. If the commitment seller decides not to honor the commitment (a decision denoted by "n"), and the commitment holder's (borrower's) project is successful, it will sue and win. On the other hand, if the commitment holder's project fails, it will not sue. Thus, if the commitment seller reneges, the commitment holder's payoff depends on whether its own project is successful. Moreover, since the (punitive) damages it can collect from the commitment seller depend on the success/failure of the project of the spot borrower the commitment seller loaned to at t=1, the commitment holder's payoff is also a function of the realization of that uncertainty. (We assume, without loss of generality, that the damages collected by the commitment holder when it successfully sues are unavailable to the depositors who give this borrower spot credit at t=1.) Thus, if the commitment holder as well as the spot borrower are successful, the former gets a net payoff of

$$X(a_1,G) - R_h[p(a_1)]^{-1} - V(a_1) - gR_fR_h$$
$$+ \{gR_fR_h + R_h[p(a_1)]^{-1} - gR_fR_h[p(a_1)]^{-1} - \delta + S'\},$$

where the term in the curly brackets represents the damages collected by the commitment holder. Similarly, if the commitment holder's project is successful but the spot borrower's is not, the former gets a net payoff of

$$X(a_1,G) - R_h[p(a_1)]^{-1} - V(a_1) - gR_fR_h + \{gR_fR_h + S'\},$$

where once again damages are in the curly brackets. If the commitment holder's project is unsuccessful, its net payoff is $- V(a_1) - gR_fR_h$, regardless of the spot borrower's project payoff realization. In state ξ_3, there is no loan commitment takedown, but the borrower acquires spot credit and invests. Its expected utility is U_3^1. The commitment seller's expected payoff is S. In state ξ_4, the borrower does not invest and experiences an expected utility of U_4^1. Again, the commitment seller's expected payoff is S.

Now suppose the borrower chooses a_2 at t=0 and yet decides to purchase a loan commitment, i.e., it mimics a borrower choosing a_1. In state ξ_1, there is no commitment takedown as the borrower acquires spot credit and experiences an expected utility of U_1^2. The commitment seller's expected payoff is S. In state ξ_2, the borrower will exercise the commitment. If the commitment seller honors it, the borrower's expected utility is U_c^2 and the commitment seller's expected payoff is S.[23] If the commitment seller refuses to honor the commitment, we have already established that the borrower will not sue. Thus, it will seek spot credit yielding an expected utility of U_2^2. The commitment seller's expected payoff is $p(a_1)[r(a_1|R_h) - \delta] + S$. In state ξ_3, there is no commitment takedown as the borrower acquires spot credit. The borrower's expected utility is U_3^2 and the commitment seller's expected payoff is S. In state ξ_4, the borrower does not invest and experiences an expected utility of U_4^2. The commitment seller's expected payoff is S.

In Figure 3 we have sketched a "condensed" extensive form for this game. This extensive form is drawn only for state ξ_2 because the commitment seller's metastrategy has to be evaluated for each ξ and it is relevant only for ξ_2. Payoffs are indicated at the terminal nodes with the first term representing the borrower's expected utility and the second term the commitment seller's expected payoff. For the borrower, however, we now write its expected utility in t=2 dollars with the expectation taken also across ξ realizations. This expectation is made conditional on $a_i \in \{a_1, a_2\}$ and on each of the bank's decisions, n and h. We thus have the borrower's expected utility assessed at t=0, which is when it is choosing its action. However, expectation of the commitment seller's payoff is taken at t=1, conditional on ξ_2. This is because the commitment seller knows ξ when it is deciding whether to honor the commitment. Thus, even though the extensive form focuses on the payoffs to the two parties in state ξ_2, the borrower's payoff is stated in terms of its expected utility prior to the realization of ξ whereas the commitment seller's payoff is stated in terms of its expected payoff conditional on ξ_2.

We now present explicit expressions for the payoffs stated in Figure 2 ($i \in \{1, 2\}$).[24]

$$U_1^i = p(a_i)\ X(a_i,G) - V(a_i) - gR_fR_\ell - R_\ell\ p(a_i)[p(a_1)]^{-1} \tag{5}$$

$$U_c^i = p(a_i)\ X(a_i,G) - V(a_i) - gR_fR_h - p(a_i)\delta \tag{6}$$

$$U_3^i = p(a_i)\ X(a_i,B) - V(a_i) - gR_fR_\ell - p(a_i)R_\ell[p(a_1)]^{-1} \tag{7}$$

$$U_4^i = -\ V(a_i) - gR_fR_h \tag{8}$$

$$U_2^1 = p(a_1)\ X(a_1,G) - V(a_1) - gR_fR_h - R_h \tag{9}$$

$$U_2^2 = -\ V(a_2) - gR_fR_h. \tag{10}$$

The payoffs stated in Figure 3 are made explicit below.

$$\begin{aligned}\hat{U}_h^1 &= \Theta\ \Psi\ U_1^1 + \Psi[1-\Theta]\ U_c^1 + [1-\Psi]\ \Theta\ U_3^1 + [1-\Psi][1-\Theta]U_4^1 \\ &= \Psi\ p(a_1)\ X(a_1,G) + [1-\Psi]\ \Theta\ p(a_1)\ X(a_1,B) - \Psi[1-\Theta]\ p(a_1)\delta \\ &\quad - gR_f^2 - \Theta\ R_\ell - V(a_1).\end{aligned} \tag{11}$$

$$\hat{U}_n^1 = \hat{U}_h^1 - \Psi[1-\Theta][\{r(a_1|R_h) - \delta\}\ p(a_1)\{1-p(a_1)\}\ p(a_1)S'] \tag{12}$$

$$\begin{aligned}\hat{U}_h^2 &= \Theta\ \Psi\ U_1^2 + \Psi[1-\Theta]\ U_c^2 + [1-\Psi]\ \Theta\ U_3^2 + [1-\Psi][1-\Theta]U_4^2 \\ &= \Psi\ p(a_2)\ X(a_2,\ G) + [1-\Psi]\ \Theta\ p(a_2)\ X(a_2,\ B) - \Psi[1-\Theta]\ p(a_2)\delta \\ &\quad - gR_f^2 - V(a_2) - \Theta\ R_\ell\ p(a_2)\ [p(a_1)]^{-1}.\end{aligned} \tag{13}$$

$$\hat{U}_n^2 = \hat{U}_h^2 - \Psi[1-\Theta]\ p(a_2)[r(a_1|R_h) - \delta]. \tag{14}$$

Now, define

$$S^+ \equiv [1-p(a_1)][r(a_1|R_h) - \delta][1-p(a_1)\Psi\{1-\Theta\}R_hR_f^{-1}],$$

where δ is defined explicitly in terms of exogenous parameters in (A-12) in the Appendix. Note that $0 < S^+ < \infty$. Henceforth, we shall assume that

$$S \in (0,\ S^+). \tag{PR-6}$$

With these preliminaries, we can now state the following result.

THEOREM 2: When there is a bilateral loan commitment contract between an individual commitment seller and a borrower, the commitment seller will renege on its promise. Thus, the only CPSELC involves the loan commitment contract not being accepted by the borrower.

With a bilateral credit exchange, then, we have market breakdown. The reason is that the commitment seller is not able to make a credible promise to lend under the commitment in states in which the borrower wishes to take it down. This happens despite the availability of legal recourse to the borrower and the possible imposition of a penalty on the commitment seller for unjustifiable failure to perform. Legal recourse is ineffective as a disciplining mechanism because the maximum legal penalty that can be imposed on the commitment seller is less than the gain to the commitment seller from reneging. To see why this is so, note that the commitment fee is set at t=0 to equal the expected present value of the subsidy provided to the borrower under the commitment. Thus, once the borrower finds itself in the state in which takedown is profitable (state ξ_2), the subsidy on the loan exceeds the commitment fee value at that point. By not honoring the commitment -- and lending in the spot market instead -- the commitment seller can gain if it is forced to relinquish all of its terminal wealth, conditional upon successful legal action by the borrower. Of course, this result rests on S not being too high. This is the reason for the parametric restriction on S. Our purpose is to show that even when S is not high enough to ensure contract enforceability with an individual commitment seller, it can do so with a bank.

E. Loan Commitments Issued by a Bank

Perhaps the simplest resolution of the contract enforceability problem is for the commitment seller to be a bank with $N(\geq 2)$ equityholders, 1 borrower and 1 depositor. With N sufficiently large, the bank will honor its commitment since the value of its lost projects will exceed the gain from not honoring the commitment. However, if $\nu > 0$, this resolution is inefficient relative to an alternative we will discuss shortly. The reason is that verification costs -- required to distinguish type 2-A agents from type 2-B agents -- are borne by the borrower in equilibrium, and having many equityholders per borrower increases the per capita incidence of verification costs.

Consider now a <u>large bank</u> that sells (fixed rate) loan commitments to a countable infinity of borrowers with independent k's. This bank has exactly as many depositors and equityholders as it does borrowers. Thus, the per capita incidence of verification costs will now only be ν. Assume, for simplicity, that $\nu=0$. All borrowers start out being identical at t=0, with each assessing a probability of Ψ of realizing k=G. Since there is a countable infinity of borrowers, throughout this analysis we consider the fractions of "good" and "bad" borrowers, which are just Ψ and $1-\Psi$ respectively, and write payoffs in per capita terms.[25] Green (1982) provides a rigorous justification for this procedure.

As in Boyd and Prescott (1986), our bank is "large" in the sense that it has a countable infinity of equityholders and deals with a countable infinity of depositors and borrowers, and "small" in the sense that it has no monopoly power. The latter is achieved by assuming that the fraction of all agents that deals with any bank is S.

When a bank deals with multiple loan commitment buyers at t=0, the deposit contract negotiated at t=0 must be modified to reflect the multiplicity of commitment buyers. To ensure comparability between the non-bank case analyzed previously and the bank case, we will keep the spirit of the deposit contract unchanged.

To understand the structure of the deposit contract, note first that it is no longer convenient to refer to depositors' payoffs in states ξ_1 through ξ_4. This is because these states are borrower-specific and we have many borrowers. We will, therefore, refer to depositors' payoffs in the high spot riskless rate state and the low spot riskless rate state. At t=1, if $R = R_\ell$, no borrower takes down its commitment. The bank thus lends all of its deposit funds to a countable infinity of distinct borrowers in the spot market. In a manner analogous to the non-bank case, depositors are promised $r(a_1|R_\ell) + gR_fR_\ell$ on every borrower that has a successful project realization (and hence repays its loan) and gR_fR_ℓ on every failure. We will work once again with the fractions of successful and unsuccessful borrowers, which are just $p(a_1)$ and $1-p(a_1)$ respectively, and write payoffs in per capita terms. At t=1, if $R = R_h$, then borrowers who have k=G will take down their commitments; the fraction of such borrowers is Ψ. The rest of the borrowers let their commitments expire unexercised. The deposit funds made available by such borrowers are loaned out in the spot market by the bank to other borrowers who purchased commitments at t=0. This means that if the bank honors all of its commitments which are taken down, the depositors get $\delta + gR_fR_h$ on every commitment borrower whose project is successful and gR_fR_h on every commitment borrower whose project fails. For every spot borrower the bank deals with, depositors get $r(a_1|R_h) + gR_fR_h$ if the borrower's project succeeds and gR_fR_h if it fails. On a per capita basis, therefore, depositors' (expected) payoff is $gR_fR_h + p(a_1)[\Psi\delta + \{1-\Psi\} r(a_1|R_h)]$, whereas the bank's expected payoff is S.

Before formalizing the case of banks, it is useful to understand the intuition behind why a bank can help restore credibility. Let N be the number of loan commitment sellers (equityholders) in the coalition we call a bank. Let N_t be the number of loan commitments taken down, and let $N_g \leq N_t$ be the number of loan commitments on which the bank reneges. Let u' be the incremental per capita gain to the bank from reneging as opposed to not reneging, assuming the borrower has chosen a_1. We can now write u' as

$$u' = \zeta_1 - S,$$

where

$$\zeta_1 \equiv [1-p(a_1)]^{N_r} N_r N^{-1} [R - \delta p(a_1) - gR_f R_h p(a_1) + S] - S.$$

Now, if the bank is very large ($N \to \infty$) and reneges on all its loan commitments, then $\lim_{N_r \to \infty} [1-p(a_1)]^{N_r} = 0$. Thus, $\lim_{N_r \to \infty} \zeta_1 = 0$, implying $u' = -S$. On the other hand, if a very large bank reneges on only one loan commitment, then $N_r N^{-1} = N^{-1}$, and thus, $\lim_{N \to \infty} \zeta_1 = 0$. Once again, $u' = -S$. In words, this means that, as long as there is a finite number of reneged loan commitments, there is a nonzero probability that the bank will escape legal punishment. However, the formation of a bank affects the incentives to renege. As the bank reneges on more and more loan commitments, the probability of going unpunished diminishes. This can be offset by reneging on fewer and fewer loan commitments, but as bank gets larger, the profits from reneging are pro-rated over a greater number of equityholders. In either case, the per capita gains from reneging vanish with increasing bank size. Although for any finite N, there will generally be an optimal N_r, we will assume that, if the bank reneges, it will renege on all its commitments. This does not sacrifice much since we focus on an infinitely large bank for which there is no optimal N_r. Note, however, that an infinitely large bank is unnecessary to establish credibility. It is clear that $u' < 0$ will generally be attained for a finite N.

Now suppose $R = R_h$ at t=1 and the bank refuses to honor any of the commitments taken down. Consequently, it will lose all of its equity, including the commitment fee revenue, if any commitment holder successfully sues. Moreover, all of the depositors' funds will be invested in spot loans. For depositors to obtain the same (expected) payoff as in the case in which the bank honors its commitments, the deposit contract must be modified as follows. If at least one commitment holder successfully sues, then on a fraction Ψ of the spot loans that are successfully repaid -- these are the spot loans that "replace" the loans that should have been made to the commitment holders who exercise -- depositors get $\delta + gR_fR_h[\Psi p(a_1)]^{-1}$ per loan, whereas on the remaining successfully repaid spot loans, depositors get $r(a_1|R_h)$ per loan. Depositors get nothing on a loan that is not repaid. If no commitment holder sues, then depositors get $\delta + gR_fR_h$ on a fraction Ψ of all successfully repaid spot loans, $r(a_1|R_h) + gR_fR_h$ on the remaining successfully repaid spot loans, and gR_fR_h on a loan that is not repaid. Once again we see that depositors' per capita (expected) payoff is $gR_fR_h + p(a_1)[\Psi\delta + \{1-\Psi\}r(a_1|R_h)]$ in the limit as $N\to\infty$ which is exactly the same as it is when the bank honors its commitments.

Thus, the structure of the deposit contract in the bank case mimics that in the non-bank case. The only difference is that an adjustment is made in the bank case to allow for the possibility of only a fraction of the bank's commitment customers exercising their commitment options. Table 3 lists the depositors' and the bank's payoffs in different states for alternative bank strategies. We can now state our final result.

THEOREM 3: There exists a CPSELC involving banks, each dealing with a countable infinity of borrowers, such that each borrower purchases a loan commitment at t=0 and chooses a_1 and each bank honors every commitment at t=1.

This theorem makes two key points. First, a (large) bank can resolve the ex post contract enforceability problem that plagues a bilateral credit transaction involving an individual lender and a single borrower. This is despite the fact that a borrower has recourse to the <u>same</u> legal punishment mechanism when dealing with a bank that reneges on its commitment as it does when dealing with an individual lender. In both cases, the maximum penalty that can be imposed on the lender is the loss of all of its terminal equity. The difference between the two cases, of course, lies in the <u>effectiveness</u> of the legal punishment mechanism. This effectiveness increases with the size of the commitment seller and attains its maximum for an infinitely large bank.

The second key point of this theorem is that we have an economic rationale for the existence of a bank. With contract enforceability problems, intermediation serves to bring borrowers and lenders (depositors) together for contractual credit exchange. Because bilateral contracts suffer from lack of credibility and the legal system is ineffective in restoring incentives to honor contracts, a <u>non-organizational</u>, market-mediated equilibrium fails to exist. This potential market failure creates a natural impetus for the emergence of organizations to intermediate between individual borrowers and lenders in a manner that assures credibility. Organizations can be "trusted" to honor contracts that individuals cannot.

It is useful to compare our result on bank existence with the contemporary literature; examples are Boyd and Prescott (1986), Diamond (1984), Ramakrishnan and Thakor (1984) and Millon and Thakor (1985). In Boyd and Prescott, banks arise because they are the most efficient producers of costly information subsequent to contracting in an environment in which private information exists prior to contracting. In the remaining three papers, intermediation causes expected contracting costs to be lowered in environments involving informational constraints. Moreover, Boyd and Prescott, Diamond, and Ramakrishnan and Thakor find that infinitely large intermediaries are optimal, whereas Millon and Thakor rationalize intermediaries of finite size. All four papers focus on spot market transactions in single period models.

There are two important distinctions between this literature and our work. First, the intermediaries in these papers do not sell contingent claims like loan commitments. Thus, they do not permit an understanding of the role of depository financial institutions in the creation and sale of credit options, forward credit contracts and other similar instruments. Second, they all assume that contracts are enforceable ex post. By contrast, we have assigned a pivotal role to contract enforceability problems and have thus highlighted a previously unexplored function of financial intermediaries, namely, the provision of credibility assurance.

V. CONCLUDING THOUGHTS

We have taken a close look at a commitment seller's incentives to honor its loan commitments. Although this contract enforceability hazard has been repeatedly acknowledged in the literature, ours is the first paper to analyze its implications.[26] Our principal findings are listed below.

(i) Loan commitments are shown to serve an economic function in an environment characterized by universal risk neutrality, takedown uncertainty and random future spot rates. In particular, a loan commitment is even more efficient than inside equity in resolving moral hazard arising from an unobservable borrower action choice.

(ii) A loan commitment can be economically valuable even when its seller's incentive to renege is explicitly allowed for.

(iii) A new economic rationale is provided for the existence of a bank. Because of contract enforceability problems, an individual lender can not make a credible promise to honor its loan commitment. Thus, a non-organizational loan commitment market cannot exist. In such an economy, banks can arise as institutions to assure credibility by restoring contract enforcement incentives.

A callous observer might say that contract enforceability is not a particularly compelling issue to focus on because instances of banks reneging are rare. This misses the point, however. Perhaps the reason why loan commitments are generally honored is that they are issued by <u>banks</u>.

It should also be noted that the way we have structured the CD contract is not the only way to give depositors an expected return equal to the riskless rate. The contract we have employed has the useful property that gains from reneging accrue to the commitment seller and the depositors' expected payoff is independent of the commitment seller's strategy. It is possible to construct alternative contracts under which the commitment seller gains nothing from reneging because depositors capture all the gains. In this case the contract enforcement problem will resurface if the commitment seller is viewed as a mutual in which depositors can exert "ownership" pressures on the commitment seller to act in a way that maximizes the depositors' ex post gains. Thus, the specific details of the deposit contract are inessential to our results. Moreover, the penalty we have assumed will be imposed on a nonperforming commitment seller is the maximum penalty. There are at least two other penalty structures that bankers believe are plausible. One is that the bank would be asked to return all the commitment fees. The other is "trebel damages," under which the bank would be asked to refund three times the fees collected. In both cases, the penalty is less severe than what we have considered. This means that the incentive to renege will be even <u>stronger</u> for an individual commitment seller, creating a further impetus for the emergence of a (large) bank. Of course, it is possible that the penalty is so weak that even a large bank has an incentive to renege. However, we have examined the weakest penalty structure -- refund of all commitment fees -- and found that a bank has an incentive to honor its commitments. Details of the analysis are available upon request.

An interesting feature of the banks in our model is that they lend through loan commitments and also directly in the spot market. This is consistent with what we observe. Moreover, they borrow long and lend both long and short. This suggests that one may be able to develop the model further to address questions such as maturity mismatching and asset-liability mix. Although there is not yet sufficient structure in the model to do this, the machinery seems to be in place. An appealing aspect of such an exercise is that one could analyze these "conventional" issues in a framework in which the bank has a reason to exist that arises endogenously in the model.

Explicit modeling of reputation would be another way to go in future research. We have ignored the role of seller reputation in a repeated setting as a mechanism for contract enforcement. It seems likely that some of the ideas in this paper can be exploited to show that banks value reputation more than individual commitment sellers, suggesting another reason for the emergence of banks as providers of credibility.

FOOTNOTES

1. Some recent papers have explained why loan commitments exist in a risk neutral setting. These are Berkovitch and Greenbaum (1986), Greenbaum, Kanatas and Vennezia (1987), Kanatas (1987), Boot, Thakor and Udell (1987) and Thakor (1987). Of these, the Boot, Thakor and Udell paper is the most closely related to ours and it is discussed later in this section. The most important difference between those papers -- including Boot, Thakor and Udell -- and ours is that we endogenously explain why the bank issuing the commitment exists, whereas they take the bank as being exogenously given. The bank has no reason to exist that is endogenously explained in those papers.

   There is also a loan commitment paper by James (1981) which assumes that banks and borrowers are risk neutral. However, that paper does not contain a formal justification for why loan commitments exist.

2. For example, Thakor and Udell (1987) assume that borrowers are risk averse, whereas Melnick and Plaut (1986) assume that banks are risk averse. The principal objective in Thakor and Udell is, however, not to explain why commitments exist. The transactions cost argument is a rather popular one in justifications of loan commitments (see, for instance, Mason (1979)).

3. Even floating rate commitments have a commitment rate that is partially rigid. For example, "prime plus" commitments hold fixed the add-on to the prime that determines the customer's borrowing rate under the commitment. See Campbell (1978).

4. See Greenbaum, Soss and Thakor (1985).

5. See, for example, Stiglitz and Weiss (1983, 1987).

6. See Thakor (1982) and Thakor, Hong and Greenbaum (1981).

7. Partial deposit insurance can be introduced without much effect.

8. Relaxing this assumption does little to alter the analysis qualitatively.

9. This random cash flow is the outcome of the borrower's action choice at t=0 and its capital investment at t=1.

10. Thus, we ignore other credit instruments like collateral that may have incentive effects. See Besanko and Thakor (1987) and Bester (1985) for analyses of the incentive effects of collateral in a pre-contract private information setting.

11. The analysis of loan commitment optimality then becomes a matter of ascertaining whether, in a universally risk neutral economy, there is any strictly positive value to diverting some of the borrower's equity to payment of the commitment fee.

12. A requirement of the equilibrium is that the bank's beliefs about a_i coincide with the borrower's choice of a_i. Of course, these beliefs will trivially coincide with the true action choice when a_i is freely observable ex post to the bank.

13. This means that the ex post information set of the borrower is partitioned finer than that of the bank.

14. One would require that none of the ex post return is observable to the bank and the borrower can divert it for its own consumption without bank detection. This makes an equity contract infeasible. However, since the bank can observe whether the project succeeded, it can penalize a borrower who defaults following project success. A sufficiently large penalty will deter successful borrowers from defaulting. Of course, penalties are not feasible when there is project failure; the borrower has no funds with which to pay the penalty.

15. The inequality below should <u>not</u> be interpreted as saying that the borrower pays a loan interest rate when it completely self-finances. However, in light of (4), we know that the product $p(a_i)r(a_i|R_j)$ equals R_j. Thus, the terms that appear as interest payments are to be interpreted merely as the borrower's opportunity costs of not investing in the riskless asset at the spot rates prevailing in those states.

16. See also Chan and Thakor (1987).

17. This also makes sense because, given our assumptions, <u>all</u> borrowers purchase loan commitments at t=0.

18. If it did not, there would be no moral hazard with spot lending.

19. Our result extends to variable rate loan commitments too since such commitments involve some fixity in the borrowing rate.

20. This observation is not new. It has been made repeatedly in the loan commitments literature. See, for example, Boot, Thakor and Udell (1987), Campbell (1978), and Thakor, Hong and Greenbaum (1981).

21. Note that we view the realization of the states ξ_i, $i \in \{1, 2, 3, 4\}$ as being specific to the bank's loan commitment customer. Since a given spot riskless interest factor realization, $R_j \in \{R_\ell, R_h\}$, is the same for <u>all</u> borrowers, when the loan commitment customer finds itself in states ξ_1 and ξ_3, the spot riskless rate for all borrowers in the economy is R_ℓ. Similarly, when the loan commitment customer finds itself in state ξ_4, the spot riskless rate for all borrowers is R_h. Note that since the k's are (pairwise) independent across borrowers, there will be borrowers who find themselves in states other than ξ_4 even when our bank's loan commitment customer finds itself in state ξ_4. Thus, these borrowers may wish to

borrow in the spot market even though the bank's loan commitment customer does not wish to invest at all.

22. Legal precedents are not of much help here since banks hardly ever renege on formal loan commitments when the borrower's financial condition is "acceptably" sound and the bank itself is solvent and financially capable of meeting its commitment obligation. Thus, practice seems to bear out what we eventually characterize as an equilibrium.

23. Given the nature of the deposit contract, the expected loss that occurs in this case is absorbed by the depositors. This is why depositors' beliefs about the borrower's action choice are important.

24. The expressions below make explicit our earlier statement that a borrower who purchases a loan commitment at t=0 can borrow in the spot market at t=1 as if it had chosen a_1 at t=0, regardless of its actual action choice at t=0.

25. See Boyd and Prescott (1986) for a similar approach.

26. Kanatas (1987) introduces the possibility of the commitment seller reneging, but he does not endogenize the seller's incentives to renege. Moreover, he does not address the bank existence issue.

APPENDIX I

Discussion of Terms Used In Definition of Equilibrium

Metastrategy: A metastrategy for a given player prescribes for each of that player's information sets and beliefs over that information set the action that the player will take. For the commitment seller in our model, the metastrategy at t=1 is whether to honor the commitment or not, conditional on the observed realization of $\xi \in \Xi$ and on a particular belief about the borrower's action choice at t=0. This metastrategy is specified for each possible realization of ξ and each possible belief about a_i. Note that the borrower's observed takedown behavior at t=1 is a noninformative signal to the commitment seller about the borrower's action choice. This is because in each of the ξ_i states, the borrower's takedown behavior is the same, regardless of whether it chooses a_1 or a_2 (see Table 1.) For the borrower, we specify a metastrategy conditional on the assumption that the offered loan commitment contract is accepted by the borrower at t=0. We then also study a "generalized metastrategy" for the borrower which is not conditional upon acceptance of the loan commitment by the borrower at t=0 and thus endogenizes the borrower's decision regarding acceptance/rejection of the loan commitment at t=0. Finally, the depositors' metastrategy specifies how they will price the two-period CD, conditional upon their beliefs regarding the action the borrower will choose and the commitment honoring strategy of the commitment seller.

Updating Rule: Since neither the borrower nor the depositors have an opportunity to update their beliefs, we can confine attention to the way the commitment seller updates its beliefs. An updating rule for the commitment seller simply specifies the belief the commitment seller has at each of its information sets as a function of its beliefs in the past. The commitment seller in our model starts out with some belief about the action the borrower will choose prior to offering it a commitment contract and then revises this belief based on whether or not the borrower accepts the contract. (There are two other opportunities for the commitment seller to revise its belief. One is following the borrower's takedown decision at t=1. However, as indicated earlier, takedown behavior is noninformative about a_1. Thus, the lender will not revise its belief. The other opportunity is after observing the borrower's decision of whether or not to sue subsequent to reneging by the lender in state ϵ_2. While this observation is informative -- only a borrower which chose a_1 sues -- the lender has no decision left, making its belief revision is irrelevant.)

Sequential Perfection: A metastrategy and updating rule for the commitment seller are sequentially perfect if, at each information set and for each belief, the metastrategy prescribes the usual best response.

Credible Updating: An updating rule for the commitment seller is credible if the belief assigned by the updating rule at each of the commitment seller's information sets is "consistent." Consistency is essentially a restriction on how the commitment seller revises its beliefs. Upon observing the borrower's decision of whether or not to accept the commitment, the commitment seller should revise its belief about the borrower's action choice in such a way that if the commitment seller then decides to honor/not honor the commitment in accordance with (the metastrategy prescribed by) this revised belief, then the borrower is better off having chosen the action the commitment seller believes it will under its new beliefs. (See Grossman and Perry (1986) for a formal discussion).

APPENDIX II

PROOF OF LEMMA 1: We will first prove that the allocation described in the lemma is indeed a Nash equilibrium (N.E.). A necessary condition for this to be a N.E. is

$$p(a_2) \sum_{\xi_i \in \Xi} Pr(\xi = \xi_i)[X(a_2, k(\xi_i)) - r(a_2|R(\xi_i))] - V(a_2)$$

$$\geq \tag{A-1}$$

$$p(a_1) \sum_{\xi_i \in \Xi} Pr(\xi = \xi_i)[X(a_1, k(\xi_i)) - r(a_2|R(\xi_i))] - V(a_1)$$

where $k(\xi_i)$ means the realization of k corresponding to the realization ξ_i and $R(\xi_i)$ means the realization of R corresponding to the realization ξ_i. Recall that $r(a_1|R_j)$ is defined in (4). A comparison of (A-1) with (PR-2) now reveals that (A-1) is a weaker condition. Thus, this equilibrium is supported by the bank believing the borrower has chosen a_2 and the borrower believing that the bank will extend credit to it at $r(a_2|R_\ell)$ if $R = R_\ell$ and at $r(a_2|R_h)$ if $R = R_h$. Both beliefs are rationalized in equilibrium. Moreover, the bank earns zero expected profit and, given this system of beliefs, there is no other contract that can make the borrower strictly better off. All that remains to be shown in order to establish this as a N.E. is that the borrower's expected utility is non-negative. Using (PR-3), the borrower's expected utility can be written as

$$p(a_2)\{\Theta\Psi[X(a_2, G) - r(a_2|R_\ell)] + \Theta[1-\Psi][X(a_2, B) - r(a_2|R_\ell)]\} - V(a_2). \tag{A-2}$$

From (PR-5) we see that (A-2) is strictly positive. Thus, this is a N.E. Verification that this yields a lower expected utility than first best now follows directly from (PR-1').

Note that any N.E. involving the bank lending at $r(a_2|R_j)$ if $R = R_j$ for one $j \in \{h, \ell\}$ and rationing otherwise is strictly Pareto dominated by the N.E.

above. Thus, we need not consider those N.E. Also, "mixed action" contracts, involving $r(a_i|R_\ell)$ if $R = R_\ell$ and $r(a_j|R_h)$ if $R = R_h$, with $a_i \neq a_j$, can never be N.E.

Thus, the only candidates for N.E. that we need to examine are those involving (i) the bank charging $r(a_1|R_\ell)$ if $R = R_\ell$ and rationing otherwise and (ii) the bank charging $r(a_1|R_h)$ if $R = R_h$ and rationing otherwise. The reason why these are the only two remaining candidates is twofold. First, (PR-2) precludes a N.E. in which the bank charges $r(a_1|R_\ell)$ if $R = R_\ell$ and $r(a_1|R_h)$ if $R = R_h$. And second, an allocation involving the bank charging $r(a_i|R_\ell)$ if $R = R_h$ or $r(a_i|R_h)$ if $R = R_\ell$ can never be a N.E. in the spot credit market because it would entail the bank making either a positive expected profit or a negative expected profit.

Now suppose the bank charges $r(a_1|R_\ell)$ if $R = R_\ell$ and rations otherwise. Since the borrower must correctly anticipate this credit policy in equilibrium, it will assess its expected utility from choosing a_1 as

$$p(a_1)\{\Theta\Psi[X(a_1,G) - r(a_1|R_\ell)] + \Theta[1-\Psi][X(a_1,B) - r(a_1|R_\ell)]\}-V(a_1) \quad \text{(A-3)}$$

and its expected utility from choosing a_2 as

$$p(a_2)\{\Theta\Psi[X(a_2,G) - r(a_1|R_\ell)] + \Theta[1-\Psi][X(a_2,B) - r(a_1|R_\ell)]\}-V(a_2). \quad \text{(A-4)}$$

Note now that (PR-3) implies that $X(a_2, G) - r(a_1|R_h) < 0$ whereas $X(a_1,G) - r(a_1|R_h) > 0$. Moreover, $X(a_1, B) - r(a_1|R_h) > X(a_2, B) - r(a_1|R_h)$. Using these observations in conjunction with (PR-2) implies that (A-4) strictly exceeds (A-3). Thus, the bank's belief about the borrower's action choice is not rationalized and this is not a N.E.

Next suppose the bank charges $r(a_1|R_h)$ if $R = R_h$ and rations otherwise. The borrower's expected utility from choosing a_1 is

$$p(a_1)\{[1-\Theta]\Psi[X(a_1, G)-r(a_1|R_h)] + [1-\Theta][1-\Psi][X(a_1, B)-r(a_1|R_h)]\}$$
$$- V(a_1). \tag{A-5}$$

But from (PR-3), $X(a_1, B) - r(a_1|R_h) < 0$. Now from (PR-4), it follows that the expression in (A-5) is strictly negative. This violates a requirement of the equilibrium. Hence, this is not a N.E. either. Q.E.D.

<u>PROOF OF THEOREM 1</u>: Define $\omega \in (0, 1)$ as the fraction of the investment that the borrower self-finances in conjunction with spot borrowing. Given the \$1 required investment, ω can also be defined as the dollar amount of equity invested in the project by the borrower. The remaining investment, \$1 - ω, is financed with a bank loan. To resolve the moral hazard problem in this case -- ensure that a_1 is chosen -- one should select ω such that the following incentive compatibility condition is met

$$\omega\{\Psi p(a_1)X(a_1,G) + \Theta[1-\Psi]p(a_1)X(a_1,B) - \Theta R_\ell - \Psi[1-\Theta]R_h - V(a^1)\}$$
$$+ \{1-\omega\}\{\Theta \Psi p(a_1)\lambda_2 + [1-\Theta]\Psi p(a_1)\lambda_3 + \Theta[1-\Psi]p_(a_1)\lambda_4 - V(a_1)\}$$
$$\geq \tag{A-6}$$
$$\omega\{\Theta \Psi p(a_2)X(a_2,G) + \Theta[1-\Psi]p(a_2)X(a_2,B) - \Theta R_\ell - V(a_2)\}$$
$$+ \{1-\omega\}\{\Theta \Psi p(a_2)\lambda_5 + \Theta[1-\Psi]p(a_2)\lambda_6 - V(a_2)\}$$

where
$$\lambda_2 \equiv X(a_1,G) - r(a_1|R_\ell)$$
$$\lambda_3 \equiv X(a_1,G) - r(a_1|R_h)$$
$$\lambda_4 \equiv X(a_1,B) - r(a_1|R_\ell)$$
$$\lambda_5 \equiv X(a_2,G) - r(a_1|R_\ell)$$
$$\lambda_6 \equiv X(a_2,B) - r(a_1|R_\ell).$$

Using a little algebra and rewriting (A-6) yields

$$V(a_2) - V(a_1) + \Psi p(a_1)\ X(a_1,G) + \Theta[1-\Psi]p(a_1)\ X(a_1,B)$$
$$- \Theta\ \Psi p(a_2)\ X(a_2,G) - \Theta[1-\Psi]p(a_2)\ X(a_2,B) - \Theta p(a_1)r(a_1)$$
$$- [1-\Theta]\Psi\ p(a_1)\ r(a_1|R_h) + \Theta p(a_2)\ r(a_1|R_\ell)$$
$$\geq \tag{A-7}$$
$$\omega\{ - \Theta[p(a_1) - p(a_2)]r(a_1|R_\ell)\},$$

which implies that

$$\omega \geq \{V(a_1) - V(a_2) - \lambda_7\}\{\Theta[p(a_1) - p(a_2)]r(a_1|R_\ell)\}^{-1} \tag{A-8}$$

where

$$\lambda_7 \equiv p(a_1)\{\Psi X(a_1,G) + \Theta[1-\Psi]X(a_1,B) - \Theta r(a_1|R_\ell) - [1-\Theta]\Psi\ r(a_1|R_h)\}$$
$$- p(a_2)\{\Psi X(a_2,G) + [1-\Psi]\ X(a_2,B) - r(a_1|R_\ell)\}\Theta$$

Now suppose the borrower purchases a loan commitment and pays a commitment fee of g at t=0. The incentive compatibility condition in this case is

$$p(a_1)\{\Theta\ \Psi\lambda_2 + \Theta[1-\Psi]\lambda_4 + \Psi[1-\Theta][X(a_1,\ G) - \delta]\} - V(a_1)$$
$$\geq \tag{A-9}$$
$$p(a_2)\{\Theta\ \Psi\lambda_5 + \Theta[1-\Psi]\lambda_6 + \Psi[1-\Theta][X(a_2,\ G) - \delta]\} - V(a_2),$$

where $\delta \in (R_\ell[p(a_1)]^{-1},\ R_h[p(a_1)]^{-1})$ is the (fixed) loan commitment interest factor. Note that, with this loan commitment interest factor, the borrower will exercise the commitment only when $R = R_h$. The commitment expires unexercised when $R = R_\ell$ because the customer can borrow at a lower rate, $R_\ell[p(a_1)]^{-1}$, in the spot market. It is important to note that lenders in the spot credit market are willing to lend to the borrower under the belief that the borrower chose a_1 at t=0. The reason for this belief is that it is common knowledge that the borrower purchased a loan commitment at t=0 and that the bank selling the commitment designed its commitment contract to be incentive compatible and induce a choice of a_1. Thus, the beliefs of spot lenders are rationalized in equilibrium. Of course, δ is arbitrarily chosen, but that does not sacrifice any generality since we will show that our choice of δ achieves a first best level of expected utility for the borrower. From the bank's zero expected profit condition we obtain

$$g = p(a_1)\ \Psi[1-\Theta][r(a_1|R_h) - \delta]R_f^{-2}. \tag{A-10}$$

Simplifying (A-9) gives

$$\begin{aligned}&p(a_1)\{\Psi X(a_1,G) + \Theta[1-\Psi]X(a_1,B) - \Theta r(a_1|R_\ell) - \Psi[1-\Theta]\delta\}-V(a_1)\\ \geq\ & \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \text{(A-11)}\\ &p(a_2)\{\Psi X(a_2,G) + \Theta[1-\Psi]X(a_2,B) - \Theta r(a_1|R_\ell) - \Psi[1-\Theta]\delta\}-V(a_2)\end{aligned}$$

Since this incentive compatibility condition holds tightly at the optimum, we obtain

$$\delta = [\lambda_8 - V(a_1) + V(a_2)][\Psi\{1-\Theta\}\{p(a_1) - p(a_2)\}]^{-1}, \tag{A-12}$$

where

$$\begin{aligned}\lambda_8 \equiv\ & p(a_1)\{\Psi X(a_1,G) + \Theta[1-\Psi]X(a_1,B)\} - [p(a_1) - p(a_2)]\Theta r(a_1|R_\ell)\\ & - p(a_2)\{\Psi\ X(a_2,G) + \Theta[1-\Psi]X(a_2,B)\}.\end{aligned}$$

Substituting (A-12) in (A-10) produces

$$gR_f = p(a_1)\{[p(a_1)-p(a_2)]\Psi[1-\Theta]r(a_1|R_h)-\lambda_8+V(a_1)-V(a_2)\}\lambda_8' \tag{A-13}$$

where $\lambda_8' \equiv \{R_f[p(a_1) - p(a_2)]\}^{-1}$.

Now, we want to show that $\omega > gR_f$, so that if $LR_f \in (gR_f, \omega)$, then the loan commitment can resolve moral hazard but spot borrowing cum equity cannot. Using the equation

$$R_f[p(a_1)]^{-1} = \Theta r(a_1|R_\ell) + [1-\Theta]r(a_1|R_h),$$

and (A-8) with (A-13), we know that $\omega > gR_f$ if

$$\begin{aligned}&\{V(a_1) - V(a_2) - \lambda_7\}\{\Theta r(a_1|R_\ell)\}^{-1}\\ >\ &\\ &\{[p(a_1) - p(a_2)]\Psi[1-\Theta]r(a_1|R_h) - \lambda_8 + V(a_1) - V(a_2)\}\lambda_8'' \qquad \text{(A-14)}\end{aligned}$$

where $\lambda_8'' \equiv \{\Theta r(a_1|R_\ell) + [1-\Theta]r(a_1|R_h)\}^{-1}$.

Cross multiplying in (A-14) gives

$$\Theta r(a_1|R_\ell)\{V(a_1) - V(a_2) - \lambda_7\} + [1-\Theta]r(a_1|R_h)Q$$

$$>$$

$$\Theta r(a_1|R_\ell)\{p(a_1)\Psi[1-\Theta]r(a_1|R_h) - p(a_2)\Psi[1-\Theta]r(a_1|R_h) - \lambda_8 + V(a_1) - V(a_2)\}$$

where $Q \equiv V(a_1) - V(a_2)$

$$- p(a_1)\{\Psi X(a_1,G) + \Theta[1-\Psi]X(a_1,B) - \Theta r(a_1|R_\ell) - [1-\Theta]\Psi r(a_1|R_h)\}$$
$$+ p(a_2)\Theta[\Psi X(a_2,G) + [1-\Psi]X(a_2,B) - r(a_1|R_\ell)]$$

Simplifying, we get the following condition that should hold

$$\Theta^2 r(a_1|R_\ell)p(a_2)\Psi X(a_2, G) + [1-\Theta]r(a_1|R_h)Q$$

$$>$$

$$- \Theta\ [1-\Theta]\Psi p(a_2)r(a_1|R_\ell)r(a_1|R_h) + \Theta\ \Psi r(a_1|R_\ell)p(a_2)X(a_2,G),$$

which, after some rearrangement, produces

$$- \Theta[1-\Theta]\Psi p(a_2)r(a_1|R_\ell)X(a_2,G) > - \Theta[1-\Theta]\Psi p(a_2)r(a_1|R_\ell)r(a_1|R_h)$$
$$- \{1-\Theta]r(a_1|R_h)Q. \qquad \text{(A-15)}$$

Now, using (PR-3) in conjunction with (PR-2) gives us the following version of (PR-2)

$$p(a_2)\{\Theta\ \Psi[X(a_2,G) - r(a_1|R_\ell)] + \Theta[1-\Psi]X(a_2,B) - r(a_1|R_\ell)] - V(a_2)$$

$$>$$

$$p(a_1)\{\Theta\ \Psi[Xa_1,G) - r(a_1|R_\ell)] + \Theta[1-\Psi][X(a_1,B) - r(a_1|R_\ell)]$$
$$+ \Psi[1-\Theta][X(a_1,G)- r(a_1|R_h)]\} - V(a_1),$$

and rearranging this inequality yields

$$Q > 0. \qquad \text{(A-16)}$$

Given (A-16), a sufficient condition for (A-15) to hold is

$$- \Theta[1-\Theta]\Psi p(a_2)r(a_1|R_\ell)X(a_2,G) > - \Theta[1-\Theta]\Psi p(a_2)r(a_1|R_\ell)r(a_1|R_h).$$

which implies that

$$X(a_2, G) < r(a_1 | R_h)$$

must hold. This holds by (i) of (PR-3). Thus, we have shown the strict Pareto dominance of the loan commitment over spot credit with equity for values of L satisfying $L \in (g, \omega R_f^{-1})$. It is now straightforward to verify that the borrower's expected utility with the loan commitment is the same as its first best utility. Q.E.D.

<u>PROOF OF COROLLARY 1</u>: See B-T-U (1987). Q.E.D.

<u>PROOF OF THEOREM 2</u>: Let us start with the depositors. Because the CD contract makes their payoff independent of the bank's strategy, they do not care about the bank's strategy. The only important factor is the depositors' belief about the borrower's action choice. Suppose

$$\Pr(a = a_1) = \mu_d, \ \Pr(a = a_2) = 1 - \mu_d.$$

That is, μ_d is the probability depositors attach to a choice of a_1 by the borrower and $1 - \mu_d$ is the probability they attach to a choice of a_2. We will return to these beliefs later on in the proof.

<u>Commitment Seller's Metastrategy (conditional on borrower buying loan commitment)</u>:

This is relevant only when a borrower comes for a loan commitment. The probability that the borrower will accept the loan commitment is irrelevant for the commitment seller. Let the commitment seller's beliefs about the borrower's action choice be given by

$$\Pr(a = a_1) = \mu_c, \ \Pr(a = a_2) = 1 - \mu_c.$$

Since the commitment seller is the last to move, its perfect metastrategy, m, is given by (A-17) as follows

$$m = \begin{cases} h & \text{if } \mu_c > [r(a_1|R_h) - \delta][p(a_1)\{r(a_1|R_h)-\delta\}+\{1-p(a_1)\}gR_fR_h + S]^{-1} \\ n \text{ or } h & \text{if } \mu_c = [r(a_1|R_h) - \delta][p(a_1)\{r(a_1|R_h)-\delta\}+\{1-p(a_1)\}gR_fR_h + S]^{-1} \\ n & \text{if } \mu_c < [r(a_1|R_h) - \delta][p(a_1)\{r(a_1|R_h)-\delta\}+\{1-p(a_1)\}gR_fR_h + S]^{-1} \end{cases} \quad \text{(A-1}$$

Now, because $S \in (S^-, S^+)$, it is easy to verify that

$$[r(a_1|R_h) - \delta][p(a_1)\{r(a_1|R_h)-\delta\}+\{1-p(a_1)\}gR_fR_h + S]^{-1} > 1.$$

Thus, $m = n$ is the optimal strategy of the commitment seller.

Borrower's Metastrategy:

We consider the metastrategy of the borrower when it has the choice of accepting or rejecting the loan commitment contract. Since n is a dominant strategy for the commitment seller, the borrower's only consistent belief is

$$\mu_b = \Pr(m = n) = 1,\ 1 - \mu_b = \Pr(m = n) = 0.$$

Now,

$$\hat{U}_n^2 + gR_f^2 > \hat{U}_n^2,$$

and

$$\hat{U}_n^2 > \hat{U}_n^1 \text{ (follows from (PR-2))}.$$

Thus, the borrower chooses s and a_2 as part of his metastrategy, given μ_b.

Finally, the metastrategy of the depositors is irrelevant because the commitment seller seeks no funds at t=0. Q.E.D.

PROOF OF THEOREM 3: As mentioned earlier, we will consider a bank with $N=\infty$. Because the CD contract makes the depositors' payoff independent of the bank's strategy, their beliefs about that strategy are irrelevant. Only their beliefs about each borrower's action choice matters. As in the previous proof, we designate their beliefs about that action choice by the probability μ_d. We will argue later on that the only consistent belief for depositors is to assign $\mu_d = 1$.

Bank's Metastrategy:

This is relevant only when the borrower comes for a loan commitment. The probability that the borrower will accept the loan commitment is irrelevant for the bank.

Since the bank is the last to move, its perfect metastrategy is given by

$$m = \begin{cases} h & \text{if } \mu_b > D_3\{D_3 + 2S\}^{-1} \\ n \text{ or } h & \text{if } \mu_b = D_3\{D_3 + 2S\}^{-1} \\ n & \text{if } \mu_b < D_3\{D_3 + 2S\}^{-1} \end{cases} \tag{A-18}$$

where μ_b is the probability the bank assigns to the borrower having chosen a_1, and $D_3 \equiv \Psi\{R_h - p(a_1)\delta\}$. We now discuss the bank's consistent belief at its information set. It is useful to begin by noting that $a = a_1$ is a dominant strategy for the borrower which accepts a loan commitment, since $\hat{U}_h^1 > \hat{U}_h^2$. Thus, belief of the bank (or the depositors) that puts positive weight on $a = a_2$. On the other hand, if the bank believes that the borrower chose $a = a_1$, then according to its metastrategy it must decide to honor the commitment, and this decision indeed makes it optimal for the borrower to have chosen $a = a_1$. This implies that the only consistent belief at the bank's information set is $\mu_b = 1$. Thus, the bank's optimal choice is h. The borrower -- who is the informed player in this game -- has a metastrategy which is reduced to a usual strategy, given the fact that the borrower has already accepted the loan commitment. This is because if the borrower does not accept the loan commitment, the bank has no metastrategy. Now, since $D_3\ \{D_3 + 2S\}^{-1} < 1$, we need μ_b to exceed a number less than 1 in order for m=h. This is certainly true since the only consistent belief of the bank is $\mu_b = 1$.

Note that the depositor's only consistent belief is $\mu_d = 1$, using arguments we need μ_b to exceed a number less than 1 in order for m=h. This is certainly true since the only consistent belief of the bank is $\mu_b = 1$.

Note that the depositor's only consistent belief is $\mu_d = 1$, using arguments similar to those used for the bank. Thus, they will supply deposits at the stated terms.

Generalized Borrower Metastrategy:

We now consider the borrower's metastrategy when it has the choice of accepting or rejecting the loan commitment contract. Let η be the probability assigned by the borrower that the bank will honor the loan commitment. A necessary condition for the borrower to choose to purchase the loan commitment is

$$\eta \geq [\hat{U}_n^2 + gR_f^2 - \hat{U}_n^1][\hat{U}_h^1 - \hat{U}_n^1]^{-1} \tag{A-19}$$

that We also need to rule out the possibility that it is optimal for the borrower to accept the loan commitment at t=0 and then choose a_2. (Our earlier incentive compatibility conditions do not help here since they assume η=1). Thus, we need

$$\eta \geq [\hat{U}_n^2 - \hat{U}_n^1][\hat{U}_h^1 - \hat{U}_h^2 - \hat{U}_n^1 + \hat{U}_n^2]^{-1}. \tag{A-20}$$

Now, if (A-19) holds and (A-20) does not, then the borrower will accept the loan commitment and choose a_2. So, we want (A-20) to hold automatically when (A-19) holds. In that case, a borrower which chooses a loan commitment will always choose a_1. That is, we need

$$[\hat{U}_n^2 - \hat{U}_n^1][\hat{U}_h^1 - \hat{U}_h^2 - \hat{U}_n^1 + \hat{U}_n^2]^{-1} < [\hat{U}_n^2 + gR_f^2 - \hat{U}_n^1][\hat{U}_h^1 - \hat{U}_n^1]^{-1} \tag{A-21}$$

It is easy to see that, if (A-21) holds, then η can be a probability. This is because $\hat{U}_h^1 > \hat{U}_n^2 + gR_f^2$, implying that

$$[\hat{U}_n^2 + gR_f^2 - \hat{U}_n^1][\hat{U}_h^1 - \hat{U}_n^1]^{-1} < 1.$$

As long as (A-21) holds, it is possible to have $\eta \in (0, 1]$ such that the borrower buys a loan commitment at t=0 and chooses a_1. However, we have argued that once the bank issues a commitment, its dominant strategy, in conjunction with its own consistent belief about a_i, is to honor the commitment. Thus, the only consistent belief is for the borrower to set η=1. The question now is: does (A-21) hold? To verify this, note that after some algebra, we can rearrange (A-21) as

$$\{\hat{U}_h^1 - \hat{U}_h^2 + [\hat{U}_n^2 - \hat{U}_n^1]\}\{\hat{U}_h^2 - \hat{U}_n^2\}^{-1} > \{\hat{U}_n^2 - \hat{U}_n^1\}\{gR_f^2\}^{-1}. \qquad \text{(A-21)'}$$

Now, since $\hat{U}_h^1 > \hat{U}_h^2$ and $\hat{U}_n^2 > \hat{U}_n^1$ (see the proof of Theorem 2), we are done if $\hat{U}_h^2 - \hat{U}_n^2 < gR_f^2$. But this is certainly true since $\hat{U}_h^2 - \hat{U}_n^2 = \Psi\{1-\Theta]p(a_2)[r(a_1|R_h)-\delta]$ and $gR_f^2 = \Psi[1-\Theta]p(a_1)\{r(a_1|R_h) - \delta]$. Thus, (A-21)' holds, which means (A-21) holds.

Finally, a comment on strategies off the equilibrium path. A borrower with $a = a_1$ <u>will</u> sue the bank if the latter reneges, since the borrower is better off <u>ex post</u> if it sues. Moreover, the courts <u>will</u> prematurely liquidate the bank's projects since the borrower collects $\varepsilon > 0$ per project, i.e., it is not ex post inefficient for the borrower to force the bank to liquidate its equityholders' projects.

Q.E.D.

TABLE 1: DESCRIPTION OF STATES AT t=1 AND BORROWER TAKEDOWN BEHAVIOR

State	Probability	Borrower Decisions: Action a_1	Borrower Decisions: Action a_2
$\xi_1 \equiv (G, R_\ell)$	$\Psi\Theta$	Invest, no LC takedown.	Invest, no LC takedown.
$\xi_2 \equiv (G, R_h)$	$\Psi[1-\Theta]$	Invest, takedown LC.	Invest, takedown LC (do not invest without LC).
$\xi_3 \equiv (B, R_\ell)$	$[1-\Psi]\Theta$	Invest, no LC takedown.	Invest, no LC takedown.
$\xi_4 \equiv (B, R_h)$	$[1-\Psi][1-\Theta]$	Do not invest; commitment seller can also costlessly renege on LC.	Do not invest.

Note: LC means "loan commitment."

TABLE 2: PAYOFFS OF DEPOSITORS, COMMITMENT SELLER AND BORROWER

FOR DIFFERENT STATES (EXCEPT ξ_2) AND STRATEGIES (ALL PAYOFFS AT t=2)

(Assume Borrower Chooses a_1)

STATE		DEPOSITOR'S PAYOFF		COMMITMENT SELLER'S (C.S.) PAYOFF		BORROWER'S PAYOFF	
At t=1	At t=2	C.S. Honors LC	C.S. Reneges	C.S. Honors LC	C.S. Reneges	C.S. Honors LC	C.S. Reneges
ξ_1	project succeeds	$gR_fR_\ell + R_\ell[p(a_1)]^{-1}$	$gR_fR_\ell + R_\ell[p(a_1)]^{-1}$	S	S	$X(a_1,G)-V(a_1) - gR_fR_\ell - R_\ell[p(a_1)]^{-1}$	$X(a_1,G)-V(a_1) - gR_fR_\ell - R_\ell[p(a_1)]^{-1}$
	project fails	gR_fR_ℓ	gR_fR_ℓ	S	S	$-V(a_1)-gR_fR_\ell$	$-V(a_1)-gR_fR_\ell$
ξ_3	project succeeds	$gR_fR_\ell + R_\ell[p(a_1)]^{-1}$	$gR_fR_\ell + R_\ell[p(a_1)]^{-1}$	S	S	$X(a_1,B)-V(a_1) - gR_fR_\ell - R_\ell[p(a_1)]^{-1}$	$X(a_1,B)-V(a_1) - gR_fR_\ell - R_\ell[p(a_1)]^{-1}$
	project fails	gR_fR_ℓ	gR_fR_ℓ	S	S	$-V(a_1)-gR_fR_\ell$	$-V(a_1)-gR_fR_\ell$
ξ_4	project succeeds	$gR_fR_h + R_\ell[p(a_1)]^{-1}$	$gR_fR_h + R_\ell[p(a_1)]^{-1}$	S	S	$-V(a_1)-gR_fR_h$	$-V(a_1)-gR_fR_h$
	project fails	gR_fR_h	gR_fR_h	S	S	$-V(a_1)-gR_fR_h$	$-V(a_1)-gR_fR_h$

TABLE 2': PAYOFFS OF DEPOSITORS, COMMITMENT SELLER AND BORROWER FOR STATE ξ_2 AND DIFFERENT STRATEGIES (ALL PAYOFFS AT T=2)

States at t=2		Payoff to Depositors of Commitment Seller		Commitment Seller's Payoff		Commitment Holder's Payoff	
Commitment Holder	Spot Borrower	C.S. Honors LC	C.S. Reneges	C.S. Honors LC	C.S. Reneges	C.S. Honors LC	C.S. Reneges
Project Succeeds	Project Succeeds	$gR_fR_h + \delta$	$gR_fR_h[p(a_1)]^{-1} + \delta$	S	0	$X(a_1,G)-V(a_1) - gR_fR_h - \delta$	$X(a_1,G) - V(a_1) + S' - \delta - gR_fR_h[p(a_1)]^{-1}$
	Project Fails	$gR_fR_h + \delta$	0	S	0	$X(a_1,G)-V(a_1) - gR_fR_h - \delta$	$X(a_1,G)-V(a_1) - R_h[p(a_1)]^{-1} + S'$
Project Fails	Project Succeeds	gR_fR_h	$gR_fR_h + \delta$	S	$R_h(p(a_1)]^{-1} - gR_fR_h - \delta + S$	$- V(a_1) - gR_fR_h$	$-V(a_1) - gR_fR_h$
	Project Fails	gR_fR_h	gR_fR_h	S	S	$-V(a_1) - gR_fR_h$	$-V(a_1) - gR_fR_h$

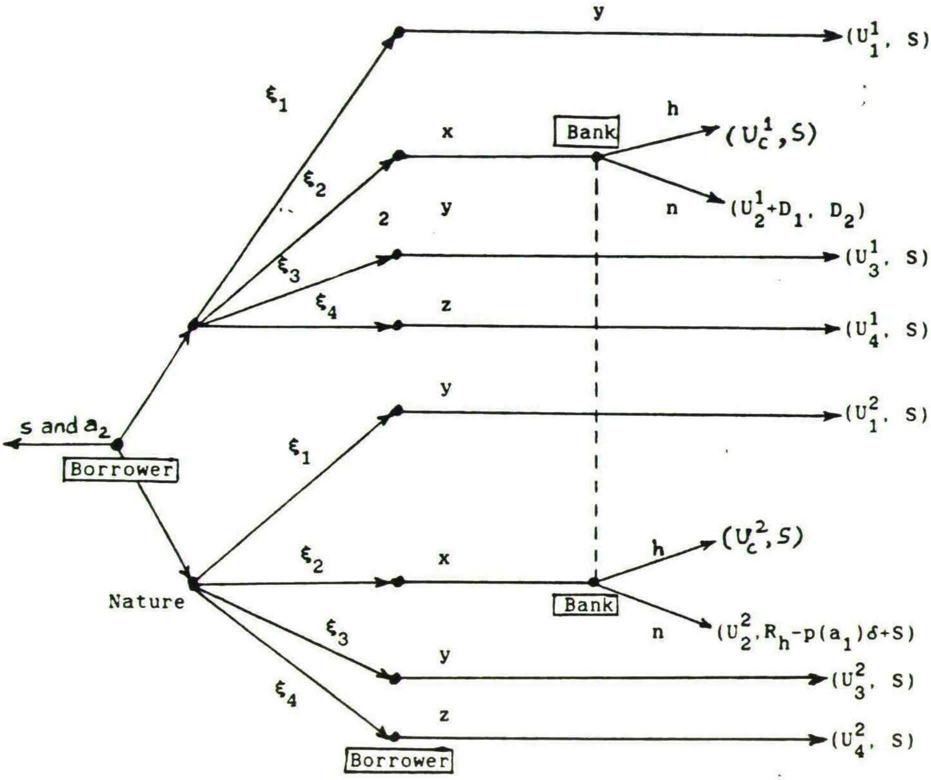
TABLE 3: PAYOFFS OF DEPOSITORS, BANK AND BORROWER IN DIFFERENT STATES AND STRATEGIES (PAYOFFS AT T=2 FOR EACH SPOT RATE REALIZATION, $R_1 \in \{R_\ell, R_h\}$, WITH EXPECTATION TAKEN ACROSS SUCCESS AND FAILURE STATES AT t=2. BORROWER CHOOSES a_1)

STATE	DEPOSITORS' PER CAPITA EXPECTED PAYOFF		BANK'S PER CAPITA EXPECTED PAYOFF		BORROWER'S EXPECTED PAYOFF		
					k = G		k = B
At t=1	Bank Honors LC	Bank Reneges	Bank Honors LC	Bank Reneges	Bank Honors LC	Bank Reneges	
$R=R_\ell$	$R_\ell+gR_fR_\ell$	$R_\ell+gR_fR_\ell$	S	S	U_1^1	U_1^1	U_3^1
$R=R_h$	gR_fR_h + $p(a_1)\Psi\delta$ $+[1-\Psi]R_h$	gR_fR_h + $p(a_1)\Psi\delta$ $+[1-\Psi]R_h$	S	-S	U_c^1	U_2^1+S' $+\Psi[R_h-p(a_1)\delta]$	U_4^1

FIGURE 1: SEQUENCE OF EVENTS

t=0	t=1	t=2
- Borrower decides to (i) purchase or not purchase a commitment (ii) choose action a_1 or a_2. - Commitment seller acquires 2-period CD's.	- Borrower quality and and spot riskless rate become symmetrically known to all agents. - Borrower decides to (i) invest or not invest (ii) exercise commitment option or not. - Commitment seller decides to honor loan commitment or not.	- Borrower's project payoff realized. - Lender and depositors paid off depending on borrower's project payoff.

FIGURE 2: EXTENSIVE FORM FOR COMMITMENT GAME

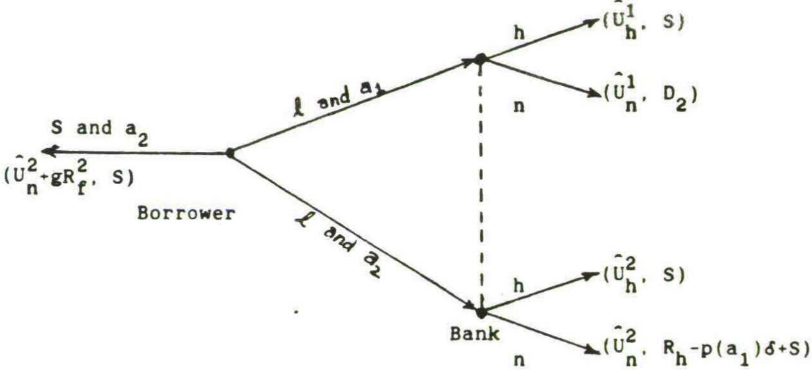


Note: At all of the decision nodes aligned vertically above or below a given box, the party whose turn it is to move is indicated in that box.

$$D_1 \equiv p(a_1)[gR_fR_h + S' + p(a_1)\{R_h[p(a_1)]^{-1} - gR_fR_h[p(a_1)]^{-1} - \delta\}]$$

$$D_2 \equiv [1-p(a_1)][R_h - p(a_1)gR_fR_h - p(a_1)\delta + S]$$

FIGURE 3: "CONDENSED" EXTENSIVE FORM FOR COMMITMENT GAME



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